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THE EFFECTS OF FINANCIAL FRICTIONS ON THE REAL ECONOMY AND FISCAL DYNAMICS

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SUMMARY

Recent trends in developed economies exhibit strong interdependencies between the financial sector's stability and macroeconomic variables. The financial sector has become a vital part of the economy, and the tendencies toward its higher complexity and greater volume as a country progresses create numerous transmission channels through which economic performance can be affected. This doctoral dissertation comprises seven chapters, in which, alongside the introduction and conclusion, there are five main chapters, which address the specific topic corresponding to investigating the issue of the effects of financial frictions on the real economy and fiscal dynamics from a particular angle. The purpose of the second chapter is to systematically present the development of the research field on the relationship between the financial and real economy by applying the bibliometric methodology and by identifying the most prolific authors, journals, and articles whose contributions have significantly influenced the stream of knowledge in the observed research field. We also present a content analysis of the top 50 most influential papers.

In the third chapter, we investigate the impact of imperfect financial markets on the business investment of Slovenian non-financial companies. We focus on exploring the borrower's balance sheet channel, through which companies' worsening balance sheets due to exogenous shocks reduce the availability of external finance. Using data from annual reports of Slovenian non-financial companies from 2005 to 2020, we estimate a panel VAR model on various sample definitions. The results confirm the existence of the balance sheet channel, as the impulse response of investment to cash flow shock is statistically significant. This effect is especially noticeable from 2006 to 2012. Our findings suggest that financial frictions affect the availability of external financing and, consequently, the investment activity of Slovenian non-financial companies. Policymakers should prioritise measures to ensure adequate external financing, particularly for financially constrained firms, to mitigate the negative impact of reduced economic activity during periods of financial distress and economic downturns.

The fourth chapter investigates the underlying credit market shocks that historically affected business investment in the Slovenian economy. In contrast to the existing literature, we explore more profound structural shocks beneath the credit demand and supply shocks. For structural identification, we propose a theoretical model of the credit market that reveals the credit market imperfections on the side of credit supply as well as credit demand. The theoretical structure justifies our set of identifying restrictions, further evaluated with the structural Bayesian VAR model. Our results confirm the relevance of loan supply shocks for business investment activity, suggesting the existence of credit market imperfections. Furthermore, business investment is strongly conditioned by liquidity demand shocks, which explain a significant part of the variation in investment activity. Even though loan supply shocks constrained the investment activity in Slovenia during the financial crisis, the results of our analysis suggest that banks predominantly

reacted to the increasing financial risk as opposed to the changes in their profit functions. Based on the results, we may conclude that in the common monetary area, fiscal policy should implement country-specific measures to address the business sector's expectations effectively regarding the economy's medium- and long-run development.

The fifth chapter investigates the importance of modelling the effects of financial frictions in the macroeconometric framework for a case of the small open economy of Slovenia. We enhanced the model with additional behavioural equations pertaining to the business and residential investment, the respective lending rates, and the non-financial companies' gross operating surplus. The estimation period spans from 1999Q1 to 2019Q4; therefore, the period of significant financial distress is included in the analysis. We conduct a counterfactual analysis by comparing simulation results from a macroeconometric model with explicit modelling of financial frictions to a model with limited transmission effects. This approach provides essential insights into the significance of incorporating financial frictions in macroeconometric models. The results indicate that financial frictions significantly hinder macroeconomic developments under adverse macroeconomic scenarios. In addition, policymakers' measures should be directed at maintaining the financial sector's stability and ensuring the availability of external funding for non-financial companies and households during the adverse economic climate.

The sixth chapter investigates the impacts of financial distress on fiscal dynamics in the euro area during the Great Recession. The period can be characterised by significant stock market declines, systemic risks, and bank failures, which compelled governments to take decisive actions to stabilise the economy and prevent a collapse of the financial sector. Unlike previous crises, these actions went beyond relying on automatic stabilisers, necessitating significant discretionary and interventionist government measures. On the sample of 20 euro area countries during the period from 1995Q1 to 2019Q4, the analysis employs a structural panel VAR approach to capture cross-country heterogeneity and distinct effects of common and idiosyncratic shocks. The results demonstrate diverse responses in government debt-to-GDP ratios and government bond yields across countries, with significant contributions from idiosyncratic shocks. Factors such as country size, trade openness, GDP per capita, financial sector size, and debt-to-GDP levels from the pre-crisis era influence the heterogeneity of these responses. These findings underscore the need to consider country-specific characteristics and idiosyncratic shocks when formulating fiscal policies in response to financial crises. Furthermore, the governments should implement short-term discretionary and interventionist measures, which should be targeted, temporary, and designed to minimise the pressures on the rising government debt-to-GDP ratio.

Keywords: financial frictions, financial crisis, business investment, credit market, fiscal dynamics

POVZETEK

Nedavni trendi v razvitih gospodarstvih kažejo na močno soodvisnost med stabilnostjo finančnega sektorja in makroekonomskimi spremenljivkami. Finančni sektor je postal pomemben del gospodarstva, težnje k njegovi večji kompleksnosti in obsegu pa z razvojem države ustvarjajo številne transmisijske kanale, prek katerih lahko vpliva na splošno gospodarsko uspešnost. Doktorsko disertacijo sestavlja sedem poglavij. Poleg uvoda in zaključka disertacija vsebuje pet glavnih poglavij, ki obravnavajo specifično temo z raziskovalnega področja preučevanja učinkov finančnih trenj na realno gospodarstvo in fiskalno dinamiko. Drugo poglavje je namenjeno sistematični predstavitvi razvoja raziskovalnega področja o medsebojnih vplivih finančnega in realnega gospodarstva z uporabo bibliometrične metodologije ter opredelitvi najvplivnejših avtorjev, revij in člankov, katerih prispevki so pomembno vplivali na tok znanja na preučevanem raziskovalnem področju. Predstavljamo tudi vsebinsko analizo 50 najvplivnejših člankov.

V tretjem poglavju raziskujemo vpliv nepopolnih finančnih trgov na poslovne investicije slovenskih nefinančnih družb. Osredotočamo se na raziskovanje transmisijskega kanala bilance stanja posojilojemalca, prek katerega se zmanjša razpoložljivost zunanjega financiranja kot posledica poslabšanja bilanc stanja podjetij zaradi eksogenih šokov. Na podlagi podatkov iz letnih poročil slovenskih nefinančnih družb med leti 2005 in 2020 ocenjujemo panelni VAR-model na različnih definicijah vzorca. Rezultati potrjujejo obstoj bilančnega kanala, saj je impulzni odziv investicij na šok v denarnem toku statistično značilen. Ta učinek je še posebej opazen v obdobju med leti 2006 in 2012. Naše ugotovitve kažejo, da finančna trenja vplivajo na razpoložljivost zunanjega financiranja in posledično na investicijsko dejavnost slovenskih nefinančnih družb. Oblikovalci politik bi morali zato dati prednost ukrepom, ki bi zagotovili ustrezno visoko raven zunanjega financiranja, zlasti za podjetja, soočena s finančnimi omejitvami, da bi ublažili negativne učinke zmanjšane gospodarske aktivnosti v obdobjih finančnih težav in gospodarskih upadov.

Četrto poglavje raziskuje temeljne šoke na kreditnem trgu, ki so v preteklosti vplivali na poslovne investicije v slovenskem gospodarstvu. V nasprotju z obstoječo literaturo raziskujemo globlje strukturne šoke, ki definirajo šoke povpraševanja in ponudbe kreditov. Za strukturno identifikacijo predlagamo teoretični model kreditnega trga, ki izpostavlja nepopolnosti kreditnega trga tako na strani ponudbe kreditov kot na strani povpraševanja. Teoretična struktura utemeljuje naš nabor identifikacijskih omejitev, ki jih dodatno ovrednotimo s strukturnim Bayesianskim VAR-modelom. Naši rezultati potrjujejo pomembnost šokov na strani ponudbe posojil za investicijsko dejavnost podjetij, kar kaže na obstoj nepopolnosti kreditnega trga. Poleg tega so poslovne investicije močno pogojene s šoki v povpraševanju po likvidnosti, ki pojasnjujejo pomemben del razlik v investicijski dejavnosti. Čeprav so šoki v ponudbi posojil med finančno krizo omejevali investicijsko dejavnost v Sloveniji, rezultati naše analize kažejo, da so se banke pretežno odzivale na naraščajoče finančno tveganje in ne na spremembe svojih profitnih funkcij. Na podlagi rezultatov lahko sklepamo, da bi morala fiskalna politika v skupnem monetarnem območju

izvajati ukrepe, specifične za posamezno državo, da bi se lahko učinkovito odzvala na pričakovanja poslovnega sektorja glede srednjeročnega in dolgoročnega razvoja gospodarstva.

V petem poglavju raziskujemo pomen modeliranja učinkov finančnih trenj v makroekonometričnem modelu slovenskega majhnega odprtega gospodarstva. Model smo nadgradili z dodatnimi vedenjskimi enačbami, ki se nanašajo na poslovne in stanovanjske investicije, pripadajoče posojilne obrestne mere ter bruto poslovni presežek nefinančnih družb. Obdobje ocenjevanja zajema obdobje od prvega četrtletja 1999 do zadnjega četrtletja 2019, kar pomeni, da vključuje tudi obdobje zadnje finančne krize. Poglavje vsebuje tudi analizo nasprotnih dejstev, ki primerja rezultate simulacij iz makroekonometričnega modela z eksplicitnim modeliranjem finančnih trenj z modelom z omejenimi transmisijskimi učinki. Ta pristop zagotavlja pomemben vpogled v pomen vključevanja finančnih trenj v makroekonometrične modele. Rezultati kažejo, da finančna trenja v neugodnih makroekonomskih scenarijih bistveno znižajo makroekonomske agregate. Poleg tega morajo biti ukrepi oblikovalcev politik usmerjeni v ohranjanje stabilnosti finančnega sektorja in zagotavljanje razpoložljivosti zunanjega financiranja za nefinančna podjetja in gospodinjstva v neugodnih gospodarskih razmerah.

V šestem poglavju smo raziskali vplive finančnih trenj na fiskalno dinamiko v evroobmočju med veliko recesijo. Za to obdobje so bili značilni veliki padci delniških trgov, sistemska tveganja in propadi bank, zaradi česar so morale vlade sprejeti odločne ukrepe za stabilizacijo gospodarstva in preprečitev zloma finančnega sektorja. Za razliko od prejšnjih kriz so ti ukrepi presegli zanašanje na avtomatske stabilizatorje in so zahtevali znatne diskrecijske in interventne vladne ukrepe. Na podlagi vzorca 20 držav evroobmočja v obdobju od prvega četrtletja 1995 do četrtega četrtletja 2019 v analizi uporabimo pristop strukturnega panelnega VAR-modela, da bi zajeli meddržavno heterogenost ter različne učinke skupnih in idiosinkratičnih šokov. Rezultati kažejo različne odzive v razmerju med javnim dolgom in BDP ter donosnostjo državnih obveznic v posameznih državah, pri čemer k temu pomembno prispevajo idiosinkratični šoki. Na heterogenost teh odzivov vplivajo dejavniki, kot so velikost države, trgovinska odprtost, BDP na prebivalca, velikost finančnega sektorja in raven dolga v razmerju do BDP iz obdobja pred krizo. Te ugotovitve poudarjajo, da je pri oblikovanju fiskalnih politik kot odzivu na finančne krize treba upoštevati značilnosti posamezne države in idiosinkratične šoke. Poleg tega bi morale vlade izvajati kratkoročne diskrecijske in interventne ukrepe, ki bi morali biti ciljno usmerjeni, začasni in oblikovani tako, da zmanjšajo pritiske na naraščajoči delež javnega dolga v BDP.

Ključne besede: finančna trenja, finančna kriza, poslovne investicije, kreditni trg, fiskalna dinamika

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sl. – Slovene

ACY – (sl. povprečno število citatov na leto); Average citations per year

AIC – (sl. Akaikejev informacijski kriterij); Akaike information criterion

AJPES – (sl. Agencija Republike Slovenije za javnopravne evidence in storitve); Agency of the Republic of Slovenia for Public Legal Records and Related Services

BAMC – (sl. Družba za upravljanje terjatev bank); Bank Asset Management Company

BIC – (sl. Bayesianski informacijski kriterij); Bayesian information criterion

BVAR – (sl. Bayesianska vektorska avtoregresija); Bayesian vector autoregression

CLIFS – (sl. indeks finančnega stresa na ravni države); Country-level index of financial stress

DSGE – (sl. dinamični stohastični model splošnega ravnotežja); Dynamic stochastic general equilibrium model

ECB – (sl. Evropska centralna banka); European Central Bank

FD – (sl. prve diference); First differences

FDI – (sl. tuje neposredne investicije); Foreign direct investment

FEVD – (sl. dekompozicija ocenjene variance spremenljivk); Forecast error variance decomposition

FOD – (sl. vnaprejšnji pravokotni odkloni); Forward orthogonal deviations

GARCH – (sl. splošna avtoregresijska pogojna heteroskedastičnost); Generalised autoregressive conditional heteroscedasticity

GDP – (sl. bruto domači proizvod); Gross domestic product

GMM – (sl. posplošena metoda momentov); Generalised method of moments

HQIC – (sl. Hannan-Quinnov informacijski kriterij); Hannan-Quinn information criterion

IMAD – (sl. Urad Republike Slovenije za makroekonomske analize in razvoj); Institute of Macroeconomic Analysis and Development, Republic of Slovenia

MMSC – (sl. modelski in momentni izbirni kriteriji); Model and moment selection criteria

NP – (sl. število objav); Number of publications

OECD – (sl. Organizacija za gospodarsko sodelovanje in razvoj); Organisation for Economic Co-operation and Development

OLS – (sl. navadni najmanjši kvadrati); Ordinary least squares

SORS – (sl. Statistični urad Republike Slovenije); Statistical Office of the Republic of Slovenia

SPVAR – (sl. strukturna panelna vektorska avtoregresija); Structural panel vector autoregression

TC – (sl. število citatov); Total citations

UCC – (sl. uporabnikovi stroški kapitala); User cost of capital

US, USA – (sl. Združene države Amerike); United States of America

VAR – (sl. vektorska avtoregresija); Vector autoregression

1 INTRODUCTION

1.1 Research topic

Over the past two decades, an ongoing debate has ensued concerning the implications of financial frictions on various crucial components that comprise the present-day global economies. Financial frictions commonly refer to obstacles, impediments, or imposed financial constraints preventing efficient capital allocation within the economy. More specifically, the existence of financial frictions creates various distortions and inefficiencies in the real economy, as the limited access of real sectors to external financial resources leads to suboptimal levels of investment and, subsequently, dampened output. These frictions may arise from information asymmetry among stakeholders in financial markets or imperfections within the financial sector. Recent trends, which can be observed in developed economies, have revealed strong interdependencies between the financial sector's stability and macroeconomic variables. It is evident that the financial sector has become a vital part of the economy, and as a country progresses, its increasing complexity and volume create numerous channels through which economic performance can be affected.

On the one hand, the financial sector is expected to provide funds that stimulate consumption and investment by households and non-financial companies, thereby representing the driving force of economic growth. On the other hand, financial market distress can lead to a significant macroeconomic downturn, as observed during the substantial financial distress during the Great Recession (2007–2009).

The aforementioned economic downturn has renewed the interest of economists and policymakers in comprehending and assessing the influence of the transmission channels between the financial and real economies. While these channels generally operate in both directions, the transmission of shocks originating in the real sectors to the financial sectors has been recognised as part of standard macroeconomic theory.

Consequently, economists have focused, particularly over the past two decades, on the crucial channels that operate in the opposite direction. Theoretical literature (Foglia et al., 2011) suggests the existence of three general groups of such channels involving the transmission of shocks originating in financial markets to the real economy or the amplification of shocks originating in the real economy by the financial markets: the borrower's balance sheet channel, the bank balance sheet channel, and the liquidity channel.

The borrower's balance sheet channel emerges due to the financial sector's inability to accurately and promptly assess the creditworthiness of borrowers (either households or companies) and monitor their investment activities. This leads to adjustments in the

external finance premium in response to general macroeconomic conditions. During economic downturns, such adjustments in the cost of external funds directly impact consumption and investment activities, further deteriorating real economic conditions. Conversely, the bank balance sheet channel arises when changes in external financing to borrowers result from the direct effects of monetary and regulatory policies on banks' balance sheets. Finally, the liquidity channel can either enhance existing transmission channels or give rise to additional channels, which occur due to changes in liquidity within financial institutions as a response to monetary policy measures.

Moreover, financial frictions and the consequences of financial distress also significantly affect the economies' fiscal position. The period of the Great Recession was characterised by stock market crashes, heightened systemic risks, and a significant number of bank defaults. Governments were compelled to implement decisive measures to sustain economic activity and prevent the financial sector's collapse. Such interventions are crucial in stabilising the economy after crisis outbreaks but can generate significant direct and indirect fiscal costs. The broader implications of economic downturns and the ensuing policy measures result in negative impacts on tax revenues and rising government expenditures through the works of automatic fiscal stabilisers.

Furthermore, the direct fiscal costs represent additional burdens on public finances resulting from the government's supplementary discretionary measures to prevent further disruptions to economic activity. During the recent financial crisis, these interventions often involved targeted packages to stabilise the vulnerable financial sector, such as banking sector capital injections, invoked guarantees payments, subsidies to non-financial companies, and payouts to depositors (Tagkalakis, 2013). Therefore, the need for fiscal stimulus in navigating financial crises and restoring financial stability is often substantial and is reflected in significant primary deficits and, consequently, the substantial increase in government debt.

1.2 Purpose, goals, and main research questions

The dissertation comprises seven chapters, of which, alongside the introduction and conclusion, there are five main chapters, which address the specific topic corresponding to investigating the issue of the effects of financial frictions on the real economy and fiscal dynamics from a particular angle. This section provides an overview of the purpose, goals, and main research questions for each chapter in the content part of the dissertation separately.

The second chapter aims to provide a systematic overview of the research conducted in the broader field of the relationship between the financial and real economy using a bibliometric methodology. This methodology allows for the identification of influential contributions, authors, and journals, providing insights into its historical development and context. The comprehensive literature review is supplemented by the content analysis of

the most influential contributions from the field in the sense of thematic analysis, data, and methodology used in the analysis and their key contributions to the field of knowledge. The performed analyses yield the opportunity to address the following research questions:

- Research Question 2.1: How did the research field of the relationship between the financial and real economy develop throughout history?

  With the exponential growth of academic publications since the 1950s, it has become increasingly challenging for the scientific community to remain current with new contributions and synthesise previous research findings. Bibliometrics offers a solution to this problem by enabling a systematic and transparent literature review based on statistical research trends. The implementation of the bibliometric methodology gives the ability to conduct a structured analysis of a rapidly expanding research field, ensuring reliability and objectivity in the process. The analysis also seeks to identify periods of increased scientific productivity and explore potential linkages between these periods and economic or financial distress observed worldwide.

- Research Question 2.2: Which are the most influential contributions that have significantly determined the evolution of the observed research field?

  Identifying the most influential contributions from the observed research field is of key importance as these contributions may represent the historical roots, which have set the grounds for further research work and significantly determined the stream of knowledge in the observed field. Moreover, the most influential contributions may belong to the various research subfields pertaining to the research field of the relationship between the real and financial economy, which is essential in uncovering the depths and complexities of the considered research field.

Focusing on the specific research subfield, the third chapter aims to examine the borrowers' balance sheet channel in the context of Slovenian non-financial companies. Specifically, the goal is to improve understanding of the impact of imperfect financial markets or the eventuality of financial distress on business investment activity. The goals of this chapter also involve identifying and analysing the determinants of business investment, both from fundamental and financial perspectives. Business investment plays a crucial role in the Slovenian economy, accounting for approximately 11% of the country's GDP (IMAD, 2023). Furthermore, given its remarkable volatility and influence on business cycles, investment also determines the long-term development of the economy to a great extent. The investigation of the borrowers' balance sheet channel allows for addressing the following research questions:

- Research Question 3.1: Is there evidence of investment-cash flow sensitivities in a sample of Slovenian companies?

Studying the investment-cash flow sensitivities pertains to investigating the financial aspects of the investment activity. Contrary to the fundamental determinants of investment, which stem from the companies' optimisation problem and set the optimal level of investment for which the marginal productivity of capital is equal to its marginal cost, the investment-cash flow sensitivities enlighten the issues pertaining to financial market imperfections and the lack of funds necessary to ensure the optimal business investment activity. On the one hand, the companies' cash flow indicates the availability of internal funds; on the other hand, it serves as a signal of the companies' creditworthiness in the attempts to raise sufficient levels of external financing sources.

- Research Question 3.2: Do financial frictions in Slovenia come to an effect through the bank-lending channel?

  Contrary to several previous studies (e.g., Melander et al. (2017), which investigated the impact of financial frictions through the lens of the investment-cash flow sensitivities), the analysis presented in this chapter accounts for the additional source of external financing, namely the outstanding loans. Such an approach allows for investigating the additional transmission channel (bank-lending channel), which may arise from the supply side of the financial sector.

- Research Question 3.3: What kind of differences can be detected in estimating the financial frictions' effects on the investment activity of Slovenian non-financial companies during various phases of the business cycle?

  The effects of financial frictions on the real economy, particularly on business investment activity, may significantly depend on the current phase of the business cycle. While the external financing constraints in the expansionary phases tend to be less binding, the recessionary periods cause lower creditworthiness of the companies and reveal financial market flaws. Hence, the impacts of the financial frictions may be especially evident during adverse economic conditions when the levels of external financing decrease significantly, further dampening economic activity.

Building on the results from the previous chapter, the purpose of the fourth chapter is to investigate the underlying credit market shocks that have historically affected business investment in Slovenia. The chapter goes beyond existing literature by exploring deeper structural shocks, which correspond to the well-known credit demand and supply shocks. To achieve this, a theoretical model is proposed, which presents a set of structural equations that are further empirically evaluated using the structural Bayesian vector autoregressive (BVAR) model. Therefore, this chapter aims to explain the transmission channels of the underlying shocks that lead to changes in the loan supply and loan demand curves. By providing explicit theoretical representation, the analysis in this chapter seeks to offer a comprehensive understanding of how these shocks impact the credit market. Hence,

the chapter contributes to a deeper understanding of the dynamics and drivers of credit markets during periods of economic distress. The results of the performed analysis shed light on the following research questions:

- Research Question 4.1: Which underlying factors may significantly determine loan demand and supply in the Slovenian credit market?

  The analysis presented in the fourth chapter challenges the conventional view that loan demand and supply shocks represent fundamental economic shocks. Instead, it argues that these shocks merely reflect underlying structural shocks: investment demand, liquidity demand, credit risk, and banks' profit function shocks. The chapter offers an alternative perspective that emphasises the significance of these underlying structural shocks in driving credit market dynamics. Furthermore, the theoretical model developed in this chapter serves as a foundation for empirically identifying the structural shocks underlying the conventional notion of the credit market.

- Research Question 4.2: What are the main determinants of the business investment activity in Slovenia over the previous two decades?

  The question focuses on investigating the determinants of Slovenian business investment activity from the financial perspective. The business investment during the last two decades seems to remain at the suboptimal level, possibly due to the limited availability of internal and external financial sources. Hence, the analysis in this chapter focuses on investigating whether the reasons behind the dampened business investment activity lie in the underlying determinants of the loan demand or the loan supply function, which yields an important result in the sense of inspecting the loan market dynamics in the Slovenian economy and its interactions with the real economy.

- Research Question 4.3: What are the main determinants of business investment during the financial crisis?

  Being regarded as the most volatile component of the GDP, inspecting the causes of decreased investment activity is especially important during periods of financial distress. In turbulent times, the attempts to transition to the economy's recovery process should be supported by promoting investment activity, especially business investment activity. However, in order to adopt targeted measures to stimulate such a recovery process, we must first investigate the underlying (financial) determinants of business investment.

Elaborating on the conclusions from the previous two chapters, Chapter Five takes on a broader perspective on investigating the impacts of financial frictions on the real economy and, to a certain degree, investigates the fiscal position's responses. Therefore, this chapter

aims to implement the transmission channels between the financial and real economy in an existing macroeconometric model of a small open economy of Slovenia. Such an approach yields the ability to examine the effects under investigation by incorporating additional data on business and residential investment, lending rates, and companies' gross operating surplus. Furthermore, the analysis presented in this chapter focuses on performing a counterfactual analysis and comparing the simulation results of the model with explicit modelling of financial frictions to those obtained from a model without their explicit modelling. The goal is to gain insights into the importance of the extended modelling of the financial sector in the macroeconometric framework and improve the understanding of its impact on the overall economy. The goal of this analysis is to address the following research questions:

- Research Question 5.1: Which transmission channels are of key importance to efficiently model the effects of financial frictions in the Slovenian economy within the existing quarterly macroeconometric framework?

  Since the financial sector is gaining a more central role in a macroeconomic framework as the economy progresses, such a trend creates numerous complex transmission channels through which the financial sector may interact with other parts of the economy. Thus, the pathway for the impact of financial frictions on the overall economy is created. This question, therefore, concerns investigating the crucial transmission channels within the existing macroeconometric model, through which the effects of financial frictions spill over to the Slovenian economy to the highest degree.

- Research Question 5.2: How do the financial frictions affect the Slovenian economy, and through which macroeconomic aggregates are the influences most observant?

  Based on the counterfactual analysis, which simulates the contribution of financial frictions to the acceleration of a macroeconomic downturn occurring as a response to distinct adverse exogenous shocks, the results may provide some insights into the magnitude of the observed impact of financial frictions in the overall economy. Moreover, the results may also enable speculation about which macroeconomic aggregates are more inclined toward exhibiting greater responses to the exogenous shocks due to the presence of financial frictions.

- Research Question 5.3: How do financial frictions affect the fiscal position of the Slovenian economy?

  Similarly to the previous question, the analysis presented in the fifth chapter also focuses on addressing the impacts of financial frictions on the fiscal position of the Slovenian economy. The observed effects are hypothetically more important during periods of financial crises, as observed in the aftermath of the Great Recession. The

policy measures implemented to regain financial and economic stability and boost the economy's recovery process are associated with significant direct and indirect fiscal costs. Hence, such an evaluation of the impacts of financial frictions is crucial to shedding some light on the existence of specific transmission channels and their consequences, which may help to design specific policy measures in order to minimise the effects of external shocks on the overall economy and the consequent pressures on the fiscal position in the future.

The purpose of the sixth chapter of the dissertation is to provide a systematic analysis of the impacts of financial shocks on fiscal dynamics within the euro area, which consists of 20 countries. The goals of this chapter are, therefore, twofold. Firstly, the analysis provides a comprehensive framework to understand how financial shocks impact variables such as debt-to-GDP ratio and government bond yield spreads. In other words, the analysis seeks to uncover the channels through which financial instability can affect public finances and to shed light on the dynamics of government debt when faced with the occurrence of financial shocks. Secondly, the analysis examines the heterogeneity among euro area countries and how it influences the magnitude of additional pressures on public finances stemming from financial sector instabilities and imbalances. Hence, the main goal of the analysis is to provide some insights into the following research questions:

– Research Question 6.1: How does the fiscal position react to the financial shock across the euro area countries?

  The attempts to stabilise the economies during periods of substantial financial distress put significant pressure on public finance. Such pressures occur as a response through the works of automatic stabilisers and additional discretionary and interventionist policy measures, such as capital injections for the banking sector. This analysis aims to shed light on the impacts of the financial shocks on the fiscal position of the euro area countries.

– Research Question 6.2: What are the possible drivers of the heterogeneous responses of fiscal position to the financial distress in the euro area countries?

  This question refers to investigating the underlying factors which tend to substantially influence the additional pressures on public finances arising from instabilities and imbalances in the financial sector. Unique features of the euro area countries, which may contribute to the heterogeneous responses of the fiscal position to a financial shock included in the analysis are GDP per capita, a dummy variable for euro area membership, trade openness, size of a country (in the sense of its population), the relative size of the financial sector, and the level of debt-to-GDP ratio.

1.3 Data and methodology

Since the doctoral dissertation aims to investigate the impact of financial frictions on the real economy and the fiscal dynamics from various angles, there is a necessity to implement a distinct methodology in order to appropriately capture the effects under investigation and address the research questions outlined in the previous section.

The analysis presented in the second chapter employs bibliometric methods to conduct a systematic and transparent literature review of the relationship between financial and macroeconomic variables. The purpose of the analysis is to overcome the challenge of staying current with the growing number of academic publications and effectively synthesising previous research findings. By using statistical measures, bibliometrics provides a structured analysis and ensures reliability and objectivity in the analysis. Based on the cited references, data analysis and visualisation are performed using an R-tool for comprehensive science mapping analysis, namely the *Bibliometrix* package (Aria & Cuccurullo, 2017). The comprehensive citation analysis for the purposes of this analysis comprises creating different networks for the co-citation, co-occurrence, and bibliographic coupling analyses, whose interpretation is presented in the second chapter, along with the identification of the most influential authors, journals, and articles, which had the most significant impact on the development of the observed field.

The data for the analysis were retrieved from the Web of Science database. The selection of the keywords used in the search term is mostly based on the previous literature, which led to the general search term that considers financial and macroeconomic terms. Specifically, we searched for the publications that include at least one of the proposed financial terms: ‘financial conditions’, ‘financial sector’, ‘financial frictions’, ‘financial accelerator’, ‘credit’, ‘financial constraints’, ‘financial market’, ‘financial variables’ and on the other hand include at least one macroeconomic term: ‘macroeconomic variables’, ‘volatility’, ‘macroeconomic’, ‘economic growth’, ‘real economy’, ‘economic activity’, ‘macroeconomy’, ‘real activity’. The final database consists of 3,997 articles published between 1974 and 2019. The database includes detailed information about titles, authors (6,482 different authors), sources of the publications (425 distinct sources), total citation counts, and the cited references for each article separately.

To investigate the existence of the borrowers’ balance sheet channel, presented in the third chapter, the necessary data for the analysis were collected from the annual reports of 2,426 Slovenian non-financial companies from 2005 to 2020, obtained from the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). The firm-level data include information on investment rates, debt rates, the marginal productivity of capital, and cash flow rates. The final dataset used in the analysis consists of 17,474 firm-year observations from Slovenian manufacturing companies. The data cleaning process involved joining information from annual reports, calculating the variables of interest, and

applying restrictions to the sample, such as including only manufacturing companies with at least 15 employees and trimming outliers.

The methodology employed in the analysis is the panel vector autoregressive (VAR) approach, which combines the traditional VAR methodology with the benefits of panel data analysis, allowing for the inclusion of unobserved individual heterogeneity. Before estimation, the stationarity of the variables was checked using the Im-Pesaran-Shin test and Fisher-type tests. The panel VAR model was estimated using the two-step generalised method of moments (GMM) procedure with a finite-sample correction. While the time-specific effects are accounted for by including the year dummy variables, the firm-specific effects are accounted for by using the forward orthogonal deviations (FOD) transformation. The comprehensive dataset and the applied methodology allow for assessing the balance sheet channel and examining the effects of financial frictions on the investment behaviour of Slovenian non-financial companies.

The analysis presented in the fourth chapter combines the theoretical aspects of imperfect capital markets with empirical estimation techniques, employing the Bayesian vector autoregressive (BVAR) model and sign restriction identification. Its primary aim is to examine the credit market dynamics within the Slovenian economy. The theoretical model is characterised as a partial equilibrium three-period model consisting of final goods producers and a banking sector. Throughout each period, the producers face uncertain production shocks. Due to the imperfections present in the capital markets, the availability of funds often deviates from the optimal investment requirements of firms. Consequently, firms are motivated to maintain liquidity reserves that enable them to approach the optimal investment level in the event of a low production shock. Two types of credit market imperfections are considered: 1) banks' expected profit function, which is concave in the outstanding amount of loans, and 2) banks' notion of uncertainty, which amplifies the probability of a low return event as they do not directly observe the producers' shock distribution.

The methodology employed in this analysis incorporates the use of sign restriction identification to identify the structural shocks. The latter is based on the theoretical model of imperfect capital markets, and it restricts the shape of impulse response functions and helps identify the relevant structural shocks. Hence, the BVAR model was estimated to test the theoretical approach's relevance to Slovenia's small open economy. The set of variables in the BVAR model allows us to recover four fundamental structural shocks of the business credit market. The model is estimated by including four endogenous variables: lending rate for non-financial firms, loans to non-financial firms, business investment, and the index of financial stress (country-level index of financial stress (CLIFS)) for Slovenia. Additionally, we controlled for the monetary policy actions by including the shadow short-term interest rate (Wu & Xia, 2017, 2020) and the general business cycle by including the euro area GDP. The dataset used has a quarterly frequency and covers the period from 1999Q1 to 2022Q3.

The fifth chapter focuses on presenting the analysis of assessing the effects of financial frictions on the macroeconomic and fiscal dynamics in Slovenia by incorporating additional transmission channels within the existing macroeconometric model of a small open economy of Slovenia. First, the existing database was enhanced by including five variables: the lending rate for non-financial companies, the lending rate for households (mortgage loans), residential investment, business investment, and the gross operating surplus and other incomes. Given the data availability, the additionally collected quarterly time series correspond to the observed period 1999Q1–2019Q4. The observed variables are expressed in real terms and do not contain unit roots.

In the most recent version of the macroeconometric model of Slovenia, private investment was modelled as a single equation. To estimate the effects of financial frictions on the Slovenian real economy, private investment was divided into business and residential investment to explicitly account for the possible differences of the spillover effects of distinct types of incomes, as well as differences in the corresponding lending rates. The lending rates for non-financial companies and households represent a linear combination of the annual differences in the short and long-term interest rates. Additionally, to capture the business incomes that may be related to the business investment, the real gross operating surplus was also included as a behavioural equation. The evaluation of the effects of financial frictions on the real economy and the fiscal position was based on the counterfactual analysis, which simulates the contribution of financial frictions to the acceleration of a macroeconomic downturn occurring as a response to distinct adverse exogenous shocks, namely the short-term interest rate shock, oil price shock, world trade shock, and the exchange rate shock.

The dataset used for the analysis presented in the sixth chapter consists of five variables at a quarterly frequency spanning from 1995Q1 to 2019Q4. The set of endogenous variables aims to capture the country-specific developments in the index of financial stress, government debt, spread between 10-year government bond yields and the 3-month Euribor, real GDP, and GDP deflator. In order to capture most of the fiscal policy dynamics in the most aggregated form, the fiscal dynamics are captured with one variable: the government debt. As our model includes the real GDP and GDP deflator as well, the development of the debt-to-GDP ratio is implicitly modelled as well. The Im-Pesaran-Shin tests (Im et al., 2003) for the time series stationarity indicate that the endogenous variables do not contain unit roots.

To address the research questions outlined in the previous section, the analysis is performed by estimating a structural vector autoregressive model using panel data (SPVAR) proposed by Pedroni (2013), which is well-suited for macroeconomic analysis of the euro area, as it allows the effects of structural shocks to be heterogeneous across countries. Furthermore, this approach allows us to transparently decompose the structural shocks into idiosyncratic and common components. The identification of the financial shock is based on the combination of sign and narrative restriction identification.

Furthermore, to shed some light on the drivers of the cross-country heterogeneity, the stepwise linear regression approach is adopted, in which the explanatory variables corresponding to the pre-crisis period (2007) are the following: GDP per capita, a dummy variable for euro area membership, trade openness (defined as a share of export and import in the GDP), size of a country (in the sense of its population), the relative size of the financial sector (calculated as the share of financial sector's value added in total value added), and the level of debt-to-GDP ratio.

1.4 Structure

This doctoral dissertation consists of five main chapters; each of the chapters tackles the issue of the impacts of financial frictions on the real economy or the fiscal dynamics from a specific point of view. Therefore, the chapters can be read individually as the structure of each chapter is such that it presents the background of the narrower research field, the performed analysis, and the main conclusions. The main chapters in the dissertation are the following:

- Relationship between the financial and the real economy: A bibliometric analysis
- The effects of financial frictions on Slovenian companies: A panel VAR approach
- Unraveling the credit market shocks and investment dynamics: A theoretical and empirical perspective
- Financial frictions in a macroeconometric model: A counterfactual analysis for the case of Slovenia
- Revisiting the impact of financial shocks on the fiscal position of euro area countries

The chapters are followed by the conclusion, whose purpose is to summarise the main findings, assess the dissertation's contribution to the body of knowledge in the observed research area, present certain limitations of the analyses, and give some insights into the possibilities for future research work. Supplementary to the main part of the dissertation, the Appendices provide an extended summary in the Slovene language and additional estimation results discussed in the dissertation.

2 RELATIONSHIP BETWEEN THE FINANCIAL AND THE REAL ECONOMY: A BIBLIOMETRIC ANALYSIS[1]

2.1 Introduction

Recent trends in developed economies exhibit strong interdependencies between the financial sector's stability and macroeconomic variables. Evidence suggests that the financial sector has become a vital part of the economy, and the tendencies toward its higher complexity and greater volume as a country progresses create numerous transmission channels through which economic performance can be affected. On the one hand, the financial sector is supposed to be providing funds to boost consumption and investment by households and firms, which induces economic growth. On the other hand, the occurrence of distress in the financial market can cause a significant macroeconomic downturn, as can be observed, for example, during the Great Recession (2007–2009).

The interrelationship between the financial and real economy also works in the opposite direction. Incomes and profits of households and firms exhibit a strong dependence on the current business cycle phase, reflected in the general financial conditions, profitability, and, consequently, stability of the financial sector. If the economy is in the phase of economic expansion, incomes increase, the borrowers' balance sheets strengthen, and hence, the economic agents' creditworthiness improves. On the other hand, recessionary periods cause lower incomes and, consequently, their creditworthiness. Moreover, since some components of fees and margin income of financial intermediaries are highly cyclical, it can be inferred that the profitability and balance sheet position of the financial intermediaries are closely related to the creditworthiness of the borrowers and consequently respond to the volatility of macroeconomic variables, which occurs due to transition of the economy across different phases of business cycles (Tsatsaronis, 2005).

Although the research community's interest in the relationship between the financial and real economy has been present since approximately the 1970s, the Great Recession can be viewed as a breakpoint as the number of publications per year on this topic started to grow exponentially in 2007. Previous studies were, to a great extent, focused on the effects of monetary policy shocks on the real economy that are caused by the changes in interest rates and consequent changes in the agents' balance sheets (Bernanke & Blinder, 1998; Bernanke et al., 1999; McCallum, 1991). However, in recent years, many studies have shown that the complex relationship between the financial and real economy does not necessarily arise from the effects of monetary policy since the fast-paced financial market developments, which are not directly connected to monetary policy, also affect the macroeconomic categories to a great extent (English et al., 2005). The effects of the

[1] The article based on this chapter has been published as: Zabavnik, D., & Verbič, M. (2021). Relationship between the financial and the real economy: A bibliometric analysis. *International Review of Economics & Finance*, *75*, 55-75.

financial market on the real economy may also stem from banking and currency crises (Kaminsky & Reinhart, 1999), financial health and stability of intermediaries (Jokipii & Monnin, 2013), financial market integration (Sutherland, 1996), general financial conditions in the economy (Swiston, 2008; Dumičić & Krznar, 2013) and also from credit availability and bank lending technologies (Ferri et al., 2019).

This chapter aims to present a systematic overview of the research in the field of the relationship between the financial and real economy by applying the bibliometric methodology. Such methodology not only allows for the identification of the most influential contributions, authors, and journals in the observed field, but it also provides some insights into the development of the field in the past and its historical context. In addition to the comprehensive literature review, which synthesises historical and ongoing research, the chapter will address some essential questions by combining conclusions from the most influential authors whose contributions were primarily influenced by specific economic periods. The data for performing a comprehensive analysis is obtained from the Web of Science Core Collection, as it is considered a high-quality database.

The rest of the chapter is organised as follows. Section 2.2 presents the data and methodology used to analyse the relationship between the financial and real economy. It is followed by the presentation of the development and recent trends of the investigated research field and an overview of the most influential and prolific authors, journals, and articles (Section 2.3). Section 2.4 provides a detailed content analysis of the field's top 50 most prolific contributions in the sense of thematic analysis, data, methodology, and key contributions to the development of the field. Finally, Section 2.5 summarises key research findings.

2.2 Data and methodology

The number of academic publications has been growing rapidly since the 1950s, which can be viewed as a historical turning point representing the entering the 'big science' era (Bornman & Mutz, 2015). This long-term upward trend is preventing the scientific community from remaining current with all contributions that are being published, and it makes the synthesising of past research findings more difficult. The approach that overcomes such problems to a great extent is the so-called bibliometrics, which has the potential to present a systematic and transparent literature review based on statistical measures of the particular line of research (Broadus, 1987). Implementing bibliometric methods is useful in research fields where the contributions are expanding at a fast pace as it ensures structured analysis. The science mapping based on the usage of bibliometric methods also has the potential gains from ensuring reliability and bringing in a greater extent of objectivity in the analysis (Aria & Cuccurullo, 2017).

The potential gains from performing such analysis caused the increasing popularity of the application of bibliometric methods, and it can be observed that its usage has been

gradually expanding to various disciplines. The general workflow of a systematic and comprehensive science mapping has been presented by Börner, Chen, and Boyack (2003) and can be characterised by five successive stages. The first step consists of outlining the research problem by defining the research questions and choosing the appropriate bibliometric methods that enable answering the proposed questions (Župič & Čater, 2015). The bibliometric analysis presented in this chapter primarily focuses on the identification of the knowledge base of the observed topic, namely the relationship between the financial and real economy and its intellectual structure. The purpose is, therefore, to identify the key scientific contributions, authors, and journals that had the most significant impact on the development of the observed research field. It is also interesting to investigate whether periods of increased scientific productivity could be related to the occurrence of some economic or financial distress. Moreover, in some parts, the analysis also focuses on investigating the research front of the chosen field.

The second step comprises the data collection to obtain the database of relevant papers, their cited references, and citation counts. For the purpose of this analysis, the chosen source of data was the Web of Science Core Collection (Clarivate Analytics, 2020) since it is considered a high-quality database in the related literature. Alternative databases, which could also be used to obtain the necessary data, are, for example, Scopus and Google Scholar. However, the citation counts obtained by Google citations are deemed to be the most generous as they also include citations from working papers and conference proceedings. Therefore, the question of data quality comes to light, which is a potential limitation that has been pointed out by some previous studies (Harzing & Alakangas, 2016).

In contrast, the citation counts obtained by the Web of Science database are considered the least generous, since they are drawn from the contributions published in the Web of Science journals index (Ahmad et al., 2020). However, the Web of Science database includes over 12,000 of the highest impact journals and over 110,000 books and conference proceedings and gives the ability to draw detailed information about the scientific publication, namely the information about title, authors, journal, publication year, cited references, total citation count and keywords to name a few. Given the dataset with complete information about publications, we are thus able to apply a variety of bibliometric methods to appropriately address the research problem outlined in the first step (Kejžar et al., 2010).

The search for relevant papers is based on a comprehensive list of keywords that should describe the considered topic most wholly and appropriately. The selection of the most important keywords is mainly based on the existing literature, which led to the general search term that considers financial and macroeconomic terms. Specifically, for the analysis, we have searched for the publications that include at least one of the proposed financial terms: ‘financial conditions’, ‘financial sector’, ‘financial frictions’, ‘financial accelerator’, ‘credit’, ‘financial constraints’, ‘financial market’, ‘financial variables’ and

on the other hand include at least one macroeconomic term: ‘macroeconomic variables’, ‘volatility’, ‘macroeconomic’, ‘economic growth’, ‘real economy’, ‘economic activity’, ‘macroeconomy’, ‘real activity’.

The search for relevant papers was conducted in September 2020; in the first step, we were able to retrieve 8,228 results. However, in the next step, the obtained database had to be cleaned to take into account only the articles from the field of interest. Using filtering of the results, we decided to focus only on the articles written in English and consider only the topics corresponding to the two research fields: business and finance, and economics. The database, therefore, consists of 3,997 articles that were published between 1974 and 2019. The scientific community that produced the chosen articles consists of 6,482 authors, implying that most articles are multi-authored (only 1,044 are single-authored). The database also includes detailed information regarding the sources of the publications (425 distinct sources), total citation counts, and the cited references (90,438 total cited references) for each article separately, which is essential for the next step of the analysis.

The last three steps in the recommended workflow for science mapping are data analysis, data visualisation, and interpretation of the results. Based on the cited references, data analysis and visualisation are performed using an R-tool for comprehensive science mapping analysis, namely the *Bibliometrix* package (Aria & Cuccurullo, 2017). The comprehensive citation analysis for the purposes of this analysis comprises creating different networks for the co-citation, co-occurrence, and bibliographic coupling analyses, whose interpretation is presented in the following section, along with the identification of the most influential authors, journals, and articles, which had the most significant impact on the development of the observed field.

2.3 Results of the bibliometric analysis

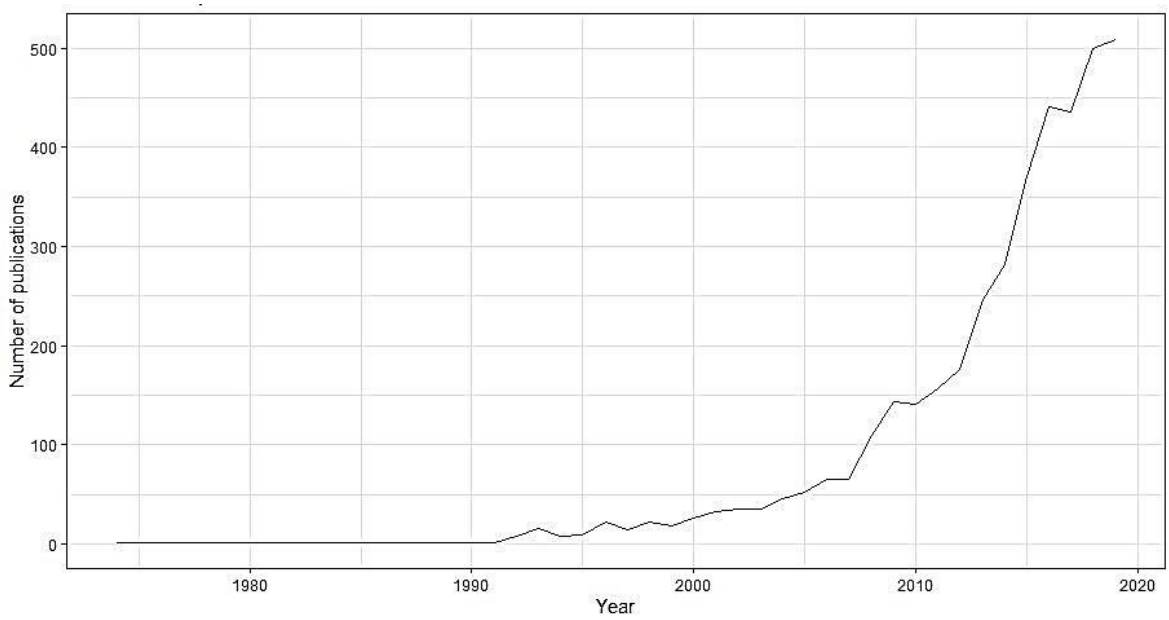
The presentation of results is divided into four subsections. The first subsection provides a systematic overview of the field; it consists of the presentation of the timeline of publications and citations and results based on the co-occurrence, co-citation, historical direct citation, and bibliographic coupling analyses. In the following three subsections, representations of the most influential authors, journals, and articles are given.

2.3.1 A systematic overview of the field

In the first set of results, we present the annual publication and total citation trends in the research field of the relationship between the financial and real economy. From Figure 2.1, which represents the timeline of scientific production, we can observe that annual scientific production in the field was relatively scarce until the 1990s, when the number of publications started to increase gradually. However, it remained relatively low until the beginning of the last global financial crisis in 2007, which boosted scientific production

significantly. Since the early 1990s, we may observe the frequent occurrences of financial crises worldwide (e.g., Finnish and Swedish banking crises (1991–1993), the Asian financial crisis (1997), the Dot.com bubble (the early 2000s), 2007–2009 financial crisis), and such frequent occurrences of crises related to financial markets are probably the reason behind the approximately exponential growth of scientific productivity in this field.

Figure 2.1: Annual publication trend (1974–2019)



Source: Own work.

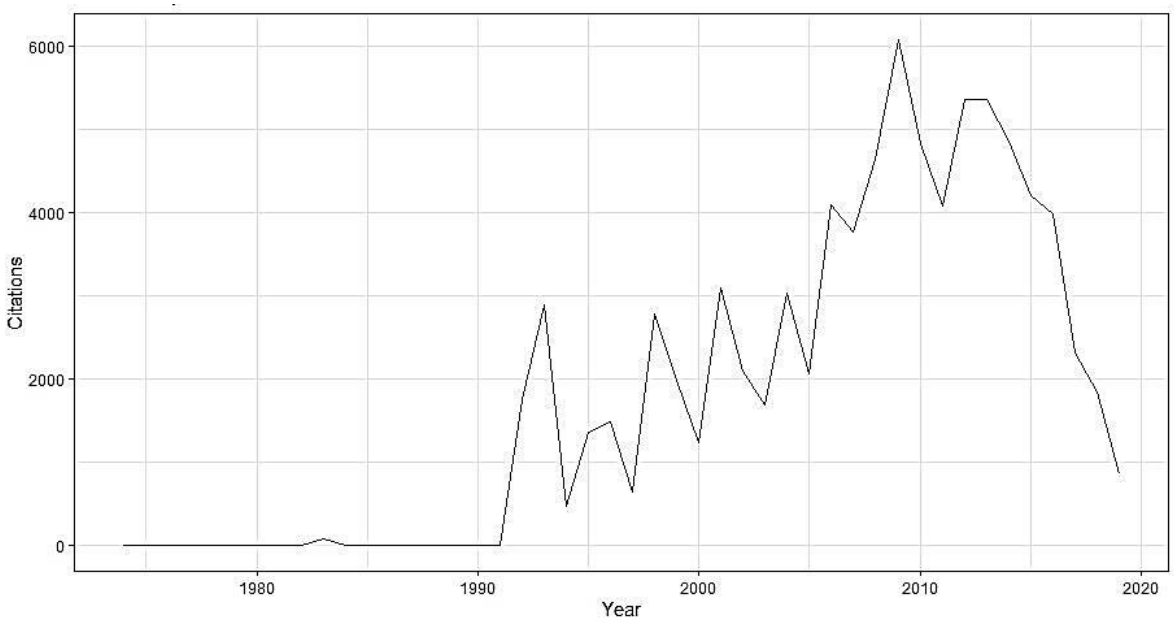
Regardless of whether they arise from the financial market imperfections and have significant adverse effects on the overall economy or work in the opposite directions, such outbreaks of crises, therefore, cause the subsequent debate on the complex relationship between financial markets and the real economy. Hence, identifying and understanding the channels through which these complex relations come into action is crucial for adequately evaluating the overall effects and the consequent measures undertaken to help the economy transition smoothly through different phases of business cycles.

From 1974 to 2019, the overall annual percentage growth rate of the number of publications was 14.85%. However, considering the breaking point, namely the Great Recession, we can observe that the trend of scientific production after the crisis has changed significantly. From 1974 to 2007, there were, on average, 14.76 new publications per year, which is relatively low compared to the productivity of the scientific community during 2008–2019, when the average number of publications per year reached 319.09.

Figure 2.2 presents another aspect of the increased interest of the scientific community in the observed field. From the figure, we can observe the total citation counts of the articles with respect to the publishing years. The peaks represent the approximate period during which the most influential articles from the field were published. The first peak (1992–

1993) is due to the three articles, which have gained much recognition among the scientific society. The first paper is by Bernanke and Blinder (1992), 'The Federal Funds Rate and the Channels of Monetary Transmission', published in the American Economic Review; the second is the contribution by Galor and Zeira (1993) 'Income distribution and macroeconomics' published in The Review of Economic Studies; the third is the article by King and Levine (1993) 'Finance, Entrepreneurship, and Growth' published in the Journal of Monetary Economics.

Figure 2.2: Annual total citation counts over the year (1974–2019)



Source: Own work.

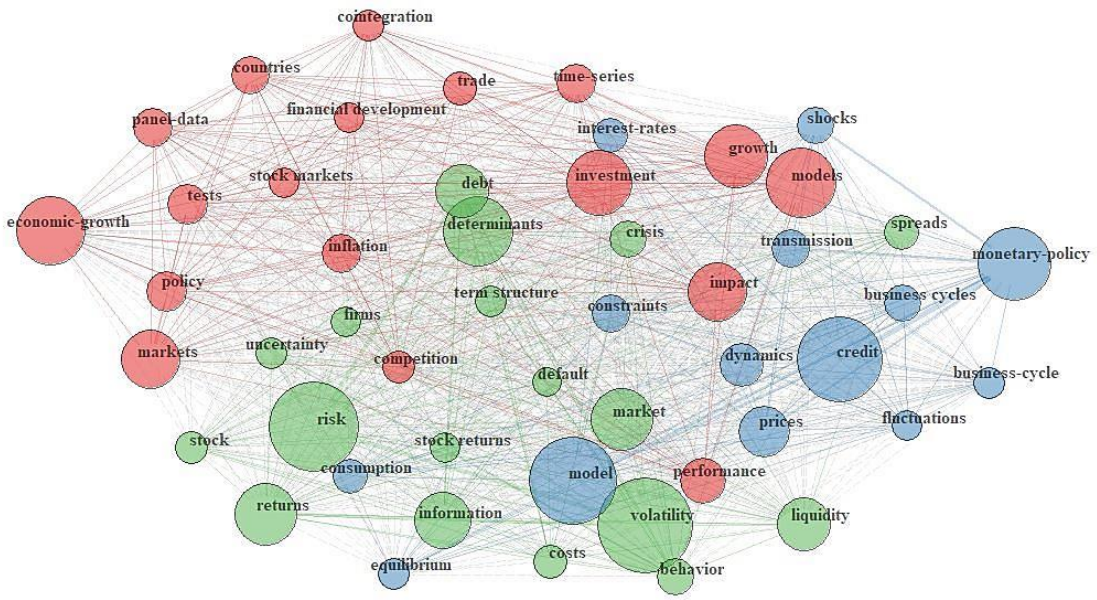
Peaks in the other periods are a consequence of many influential contributions, among which the most prominent are the following: 'The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle' by Berger and Udell (1998) published in the Journal of Banking & Finance; 'The twin crises: the causes of banking and balance-of-payments problems' by Kaminsky and Reinhart (1999) published in the American Economic Review; 'FDI and economic growth: the role of local financial markets' by Alfaro, Chanda, Kalemli-Ozcan, and Sayek (2004) published in the Journal of International Economics and 'Deciphering the liquidity and credit crunch 2007–2008' by Brunnermeier (2009) published in the Journal of Economic Perspectives.

In the next set of results, we present the outcomes of the keyword co-occurrence, authors' co-citation, bibliographic coupling, and historical direct citation analyses. The methodological design of these analyses, particularly the first three, is such that it visualises the nodes, which represent the units of analysis (keywords or articles), and the links between them, which represent connections according to similarity. While the size of the nodes corresponds to the frequency of occurrences of the observed units of analysis

across the documents in the database, the thickness of these links reflects the strength of the co-occurrence relationships between the associated units. Moreover, the distance between the nodes signifies the degree of relatedness between the observed unit of analysis (Župič & Čater, 2015). Additionally, for the purpose of improving clarity, nodes with similar attributes are systematically grouped into separate clusters distinguished by colour, which yields the ability to easily identify underlying thematic trends and connections within the bibliometric landscape.

The keyword co-occurrence analysis provides a general overview of the most important themes and research problems investigated by the articles in our database. In Figure 2.3, we present the 50 most important keywords in the field of the relationship between the financial and real economy. From the figure, it is evident that the keywords correspond to three distinct clusters that are highly intertwined. The blue cluster primarily includes macroeconomic terms related to the transmission of monetary policy. The most frequently used keywords are ‘credit’, ‘model’, and ‘monetary policy’, which appear in 424, 390, and 386 articles, respectively. Other terms which correspond to the blue cluster include: ‘transmission’, ‘shocks’, ‘prices’, ‘business cycle’, ‘interest rates’, and ‘dynamics’.

Figure 2.3: The most important keywords in research on the relationship between the financial and real economy



Source: Own work.

In contrast, the red cluster includes mainly general macroeconomic terms that capture the relationship between the financial and real economy through the transmission channels, which are not directly connected to monetary policy. The keywords used most frequently are ‘economic growth’, ‘growth’, and ‘investment’, with 322, 253, and 222 appearances, respectively. However, the red cluster also includes terms that are related to

methodological approaches, namely ‘models’, ‘panel-data’, ‘tests’, and ‘cointegration’, which exhibit strong connections with the other terms in the co-occurrence network, implying the importance of methodological approaches in the research field of the relationship between financial and real economy.

As opposed to the previous two clusters, which include general macroeconomic terms, the last (green) cluster includes keywords that seem more specific and are related to financial markets. The co-occurrence network in Figure 2.3 suggests that the strong connections between the clusters are most noticeable when observing the integration of the green cluster between the other two. This may implicate the importance of considering the specific financial factors in the observed research area. The most frequently used keywords are ‘risk’, ‘volatility’, and ‘determinants’, with 439, 401, and 271 appearances in the articles, respectively. Other most commonly used keywords in the green cluster, either independently or in relation to other keywords in the network, are: ‘returns’, ‘liquidity’, ‘information’, ‘market’, ‘debt’, ‘uncertainty’, and ‘term structure’.

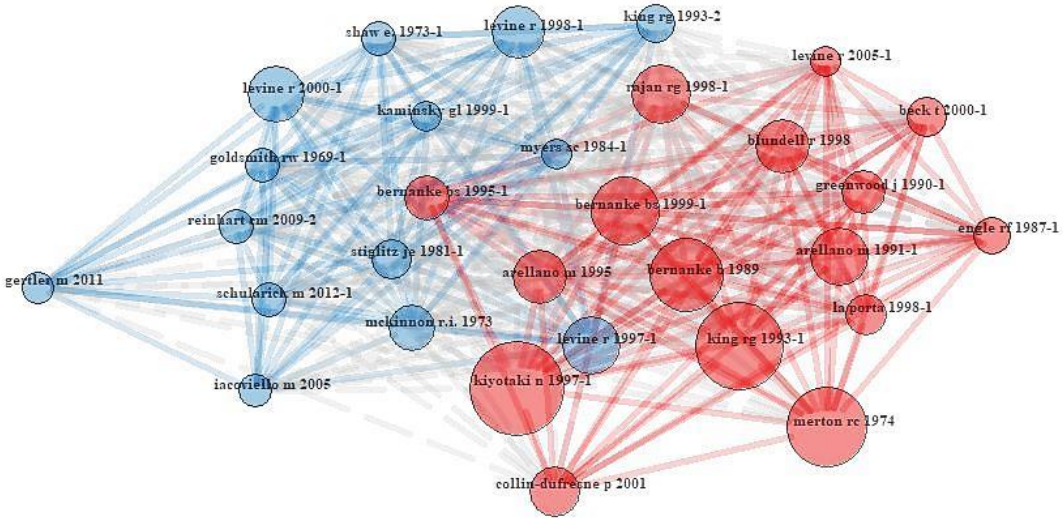
Next, we present the co-citation network. A co-citation is an approach that measures the frequency with which two articles are cited together when considering the primary papers in the database. When two papers exhibit a strong connection, meaning that they are frequently cited together, they are necessarily frequently cited individually as well (Small, 1973). This implies that we can identify them as the most influential papers whose contributions had a significant role in the development of the observed research field. Figure 2.4 presents the output of the co-citation analysis, from which we can observe two distinct clusters of the most frequently co-cited references. The red cluster includes articles roughly concerned with the transmission mechanism of the financial accelerator, through which the effects of the (negative) external shocks are amplified as a consequence of limited lending to firms that are considered non-creditworthy, which results in the deepening of the crisis.

From the figure, it can be observed that the most important contributions, in the sense of the frequency of co-citations and individual citations, include, for example, Kiyotaki and Moore (1997), who studied the dynamic interaction between credit constraints and asset prices, which turned out to be a powerful transmission mechanism by which the effects of shocks persist, amplify, and spill over to other sectors; and Bernanke and Gertler (1989) who studied the connections between the net worth of companies and agency costs and consequently the amplification of business fluctuations.

In contrast, the red cluster also includes some articles which focus on the issue of methodological approaches to comprehensively and accurately capture the observed effects; for example, Arellano and Bond (1991) presented specification tests that are applicable after estimating a dynamic panel-data model by the generalised method of moments (GMM), and Arellano and Bover (1995) developed a framework for efficient instrumental variable estimation.

Whereas the articles in the red cluster roughly capture the relationship between the financial and real economy through the point of view of companies, their net worth, and credit constraints, the articles in the blue cluster tend to capture this complex relationship more directly, for example, Levine, Loayza, and Beck (2000) examined the causal relationship between financial intermediation and economic growth; Levine (1998) studied the relationship between the legal system and banking development and the long-run economic growth; Kaminsky and Reinhart (1999) examined the causes of banking and balance-of-payments problems; and Gertler and Karadi (2011) evaluated the effects of unconventional monetary policy.

Figure 2.4: Co-citation network from the research on the relationship between the financial and real economy



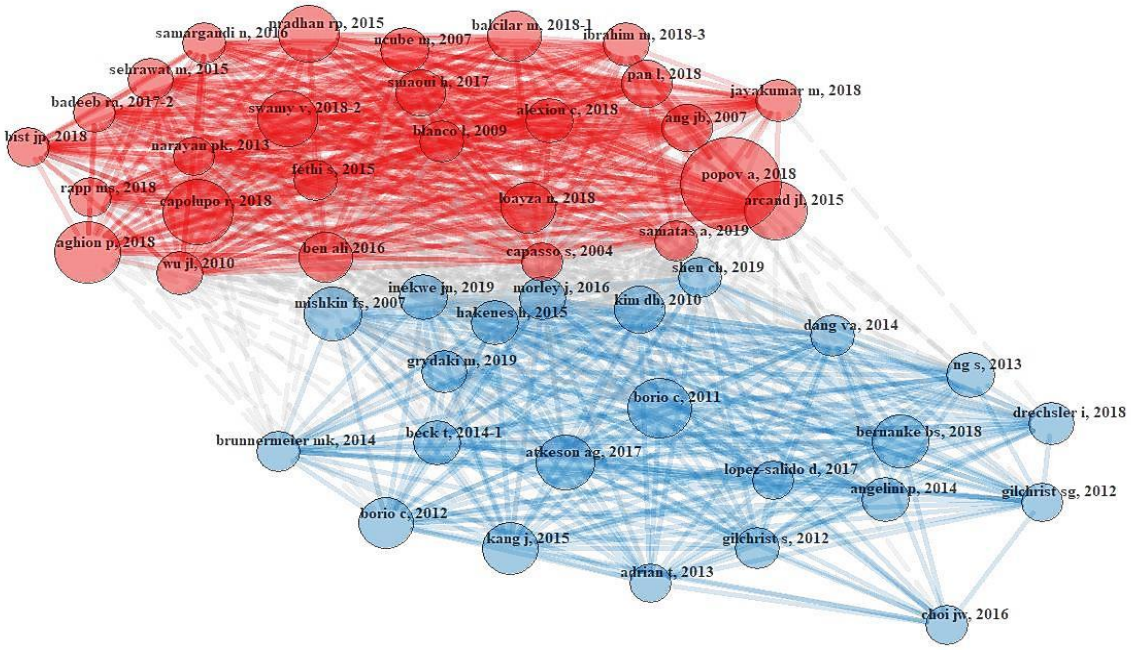
Source: Own work.

As opposed to the co-citation analysis, which focuses on the cited references of our primary papers in the database, the bibliographic coupling analysis establishes the connections between articles based on the number of shared references. Therefore, the similarities between articles are drawn from the overlap of their bibliographies (Župič & Čater, 2015). The latter technique was introduced by Kessler (1963), but despite being approximately a decade older than co-citation (Small, 1973), it has been used less frequently for science mapping. However, bibliographic coupling is gaining popularity, as it successfully overcomes some limitations of the co-citation analysis; for example, it gives the ability to more accurately present a research front of the field (Boyack & Klavans, 2010).

Figure 2.5 presents the clusters of articles obtained by bibliographic coupling while taking into account 50 articles that exhibit the strongest connections with the other articles in the

database. From the figure, it is evident that the network consists of two distinct clusters and that the similarities between articles are more evident in the case of the red cluster since the vertices tend to be closer and more connected to each other. The articles in the red cluster are mainly concerned with the specific effects of financial market development on economic growth (finance-growth nexus). For example, Aghion, Howitt, and Levine (2018) examined the effects of financial development on innovation-led growth and whether credit constraints can be treated as a potential source of cross-country divergence; Capolupo (2018) studied the finance-growth nexus in Italy; Arcand, Berkes, and Panizza (2015) investigated whether there is a threshold above which financial depth no longer has a positive effect on economic growth; and Pradhan, Arvin, and Norman (2015) searched for causal relationships between insurance market development, financial development, and economic growth.

Figure 2.5: Clusters of articles in research on the relationship between the financial and real economy



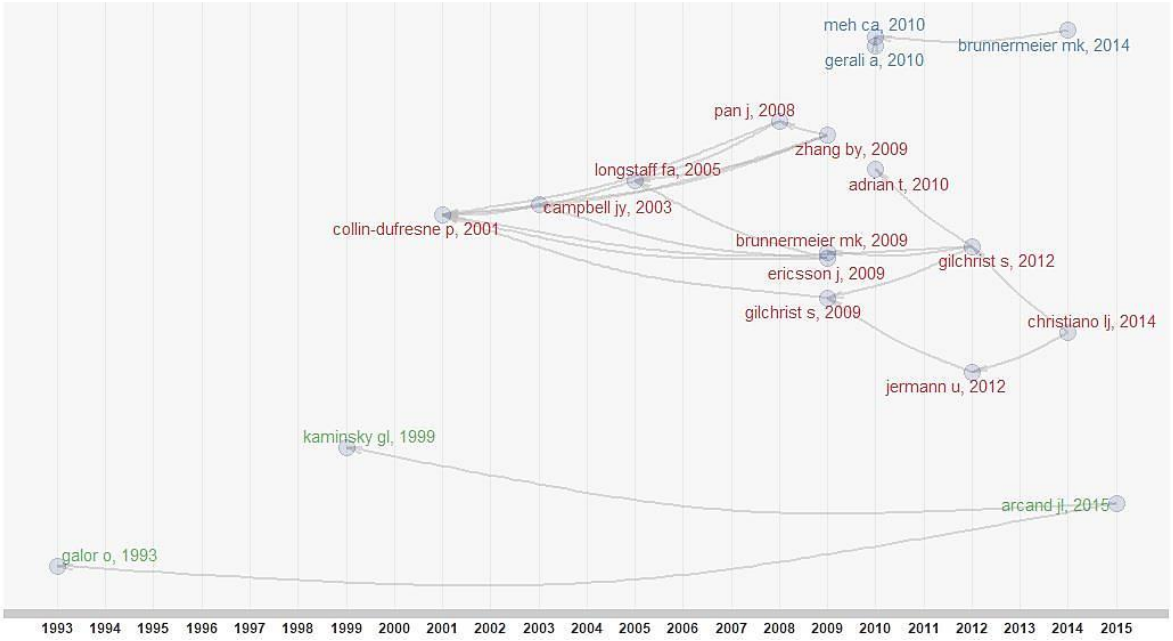
Source: Own work.

In contrast, the blue cluster includes articles that focus on the importance of the explicit modelling of financial frictions in macroeconometric models (Brunnermeier & Sannikov, 2014), the promotion of a debate regarding the effects of the credit market developments on the real economy to smooth the phases of business cycles (Bernanke, 2018), and stressing the importance of analytical approaches and policy design, which would ensure the financial stability in the economy (Borio, 2011), and the financial soundness of the firms (Atkeson et al., 2017).

Finally, Figure 2.6 presents the historical direct citation network in research on the relationship between the financial and real economy. The methodology of the direct citation analysis, proposed by Garfield, Sher, and Torpie (1964), enables tracing the historical development of the observed research field. From Figure 2.6, we can observe which contributions had the most considerable influence on the most recent articles. Evidently, the historical direct citation network can be traced back up to two decades, which roughly coincides with the increased productivity of the scientific community in the observed research field (presented in Figure 2.1).

Observing the red cluster, we can infer that the study of a standard monetary dynamic general equilibrium model augmented by the Bernanke-Gertler-Gilchrist financial accelerator mechanism by Christiano, Motto, and Rostango (2014) was primarily influenced by previous contributions. For example, Gilchrist and Zakrajšek (2012) studied the credit spread and business fluctuations; Jermann and Quadrini (2012) examined the financial shocks and their macroeconomic effects; Ericsson, Jacobs, and Oviedo (2009) searched for the linear relationship between theoretical determinants of default risk and default swap spreads; and the study by Collin-Dufresn, Goldstein, and Martin (2001) on the determinants of credit spread changes can be regarded as a scientific breakthrough, since it represents a 'historical' root for some of the most influential contributions in the observed field over the previous two decades.

Figure 2.6: Historical direct citation network in research on the relationship between the financial and real economy



Source: Own work.

2.3.2 The most prolific authors

In this subsection, we present the most productive and influential authors whose contributions have promoted the debate on the relationship between the financial and real economy and have significantly influenced the development of the research field. In Table 2.1, we present the 25 most productive authors in the sense of the number of publications (NP), which are ranked according to the total citation counts (TC). To compare scientific productivity and authors' influence, Table 2.1 also contains information on H-indices, G-indices, M-indices, number of publications, and years of scientific activity. The H-index, or Hirsch index (Hirsch, 2005), is a single-number criterion that can characterise a researcher's scientific output. However, since it is prone to some limitations, the evaluations are often also based on the G-index, M-index, or some other variety of H-index. While the G-index (Egghe, 2006) remunerates highly cited contributions, the M-index takes into account the years of scientific activity.

Table 2.1: Top 25 most influential authors based on the total citations

Rank	Author	H-index	G-index	M-index	TC	NP	Active since
1	Laeven L.	10	10	0.625	1,324	10	2005
2	Longstaff F. A.	7	8	0.438	910	8	2005
3	Adrian T.	6	10	0.462	778	10	2008
4	Claessens S.	6	7	0.375	575	7	2005
5	Smith B. D.	6	8	0.240	555	8	1996
6	Beck T.	7	9	0.350	535	9	2001
7	Aghion P.	5	7	0.294	527	7	2004
8	Gallegati M.	12	19	0.429	490	19	1993
9	Russo A.	7	10	0.583	294	10	2009
10	Gatti D. D.	7	9	0.250	281	9	1993
11	Kutan A. M.	11	16	0.393	263	16	1993
12	Gupta R.	8	13	0.667	183	14	2009
13	Hammoudeh S.	8	13	1.000	175	16	2013
14	Eickmeier S.	6	7	0.500	155	7	2009
15	Arestis P.	5	8	0.263	151	8	2002
16	Semmler W.	6	11	0.429	145	17	2007
17	Agenor P. R.	8	11	0.348	137	12	1998
18	Shahzad S. J. H.	5	10	1.250	119	10	2017
19	Balcilar M.	5	10	0.833	111	11	2015
20	Aizenman J.	4	9	0.174	96	9	1998
21	Hamori S.	6	8	0.375	86	8	2005
22	Guesmi K.	3	7	0.600	74	7	2016
23	Chen T. K.	4	8	0.400	72	8	2011
24	Caporale G. M.	4	8	0.174	71	8	1998
25	Ap Gwilym O.	5	7	0.385	69	7	2008

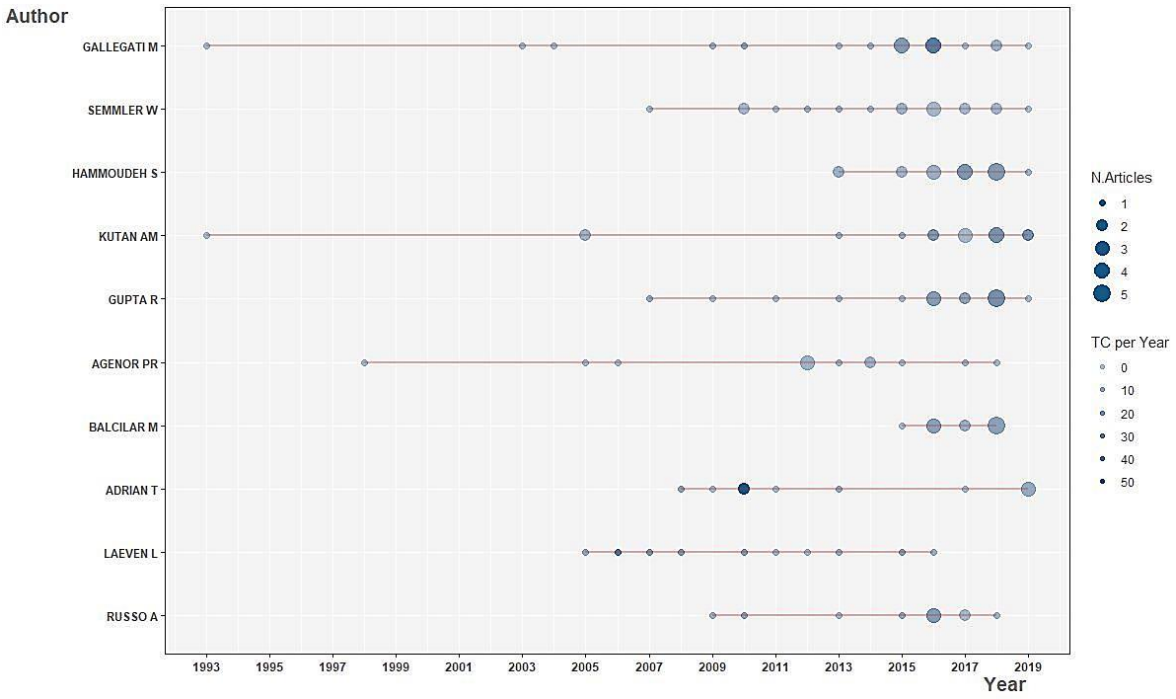
Note: TC – total citations, NP – number of publications.

Source: Own work.

According to the number of total citations, the top three authors are Laeven L., Longstaff F. A., and Adrian T., with 1,324, 910, and 778 total citations, respectively. Accounting for the general evaluations of scientific productivity and influence, the H-index and G-index

indicate that the two most influential authors are Gallegati M. and Kutan A. M. However, accounting for the career length by calculating M-index, we observe that the most influential author is Shahzad S. J. H., who has actively participated in the scientific community in the observed field since 2017. He has published 10 articles and accumulated 119 citations in this short period.

Figure 2.7: Top 10 most productive authors based on the number of publications



Source: Own work.

From Figure 2.7, we can observe the top authors' productivity based on the number of publications. The lines represent authors' timelines and years of scientific activity in the research field, the bubble sizes are proportional to the number of publications, and their colour density is proportional to the total citations per year. From the figure, it is evident that according to the number of publications, the most productive author is Gallegati M., who has been actively engaged in the scientific discussion since 1993. In line with the discussion on the timeline of publications and citations in the previous subsection, we again observe the boost in scientific productivity since the Great Recession, which is especially evident in the previous five years and may also indicate that such a trend is likely to continue.

The authors' productivity and influence can be detected through different points of view. Therefore, we present an additional author ranking in Table 2.2 based on the dominance factor. The dominance factor is calculated as the share of the first-authored articles among the multi-authored contributions. From Table 2.2, it is evident that the highest-ranking authors are Agenor P. R., Adrian T., Arestis P., and Aghion P. However, there is a

possibility that some articles' authors are ordered alphabetically, which would cause biased results and limited inference of the scientific influence based on the dominance factor.

Table 2.2: Top 25 most influential authors based on dominance factor

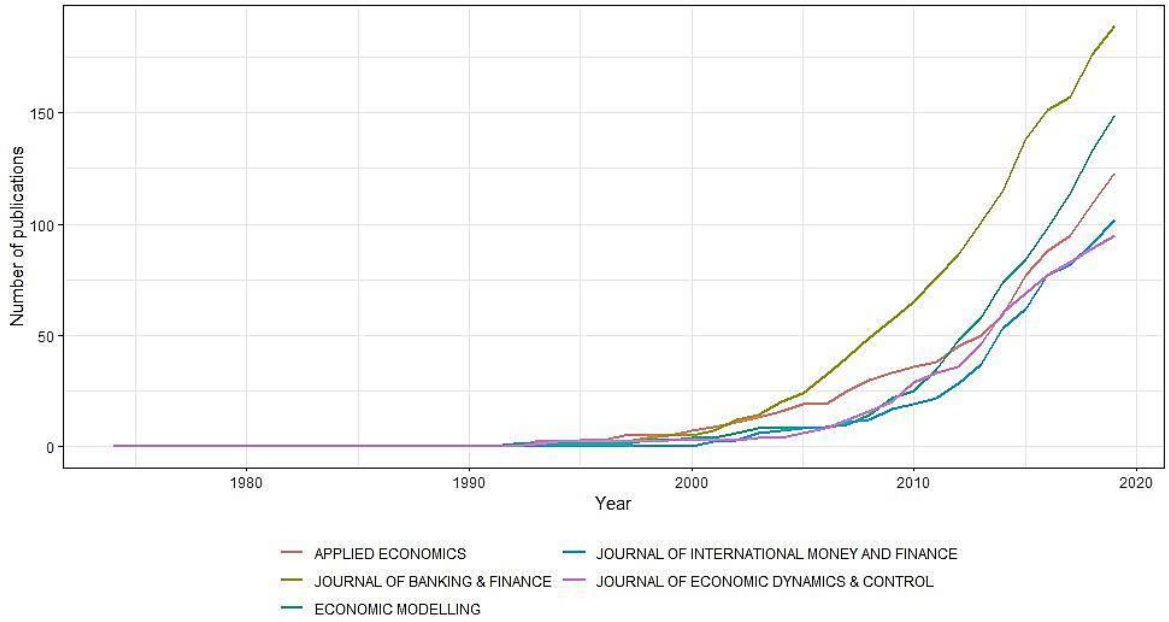
Rank	Author	Dominance factor	Number of articles	Single-authored	Multi-authored	First-authored	Rank by articles
1	Agenor P. R.	1	12	1	11	11	6
1	Adrian T.	1	10	1	9	9	8
1	Arestis P.	1	8	1	7	7	15
1	Aghion P.	1	7	0	7	7	19
5	Beck T.	0.889	9	0	9	8	12
6	Chen T. K.	0.875	8	0	8	7	15
7	Pradhan R. P.	0.857	7	0	7	6	19
8	Claessens S.	0.833	7	1	6	5	19
9	Balcilar M.	0.818	11	0	11	9	7
10	Aizenman J.	0.778	9	0	9	7	12
11	Caporale G. M.	0.750	8	0	8	6	15
12	Shahzad S. J. H.	0.700	10	0	10	7	8
13	Eickmeier S.	0.571	7	0	7	4	19
14	Gatti D. D.	0.556	9	0	9	5	12
15	Guesmi K.	0.429	7	0	7	3	19
15	Hayo B.	0.429	7	0	7	3	19
17	Laeven L.	0.333	10	1	9	3	8
18	Longstaff F. A.	0.286	8	1	7	2	15
18	Lee C. C.	0.286	7	0	7	2	19
20	Hammoudeh S.	0.188	16	0	16	3	3
21	Semmler W.	0.118	17	0	17	2	2
22	Russo A.	0.111	10	1	9	1	8
23	Gupta R.	0.077	14	1	13	1	5
24	Kutan A. M.	0.063	16	0	16	1	3
25	Gallegati M.	0.053	19	0	19	1	1

Source: Own work.

2.3.3 The most influential journals

In addition to identifying the most prolific authors, the comprehensive bibliometric analysis also suggests pinpointing the journals that significantly contribute to the body of knowledge regarding the relationship between the financial and real economy. In the first step, we have identified the top five most influential journals based on the number of publications. The timeline of the publication growth in the top journals is presented in Figure 2.8. We can observe an approximately exponential trend in scientific publications by the top journals, with the Journal of Banking & Finance identified as the leading journal in the considered research field.

Figure 2.8: Publication growth by the top 5 most influential journals (1974–2019)



Source: Own work.

In the next step, we focus on the identification of the key journals from another perspective. Therefore, Table 2.3 provides the ranking of the top 25 journals according to their total citation counts, and it also contains information on the number of publications for each journal. Based on the total citations, the most influential journals are the Journal of Banking & Finance, Journal of Finance, and American Economic Review, with 6,727, 5,155, and 5,129 total citations, respectively. However, drawing comparisons based on the number of publications or total citations may be subject to a potential issue regarding the accumulation of the citations over time, implying the advantageous position of the older contributions.

To overcome this issue, we calculated the citations per year for each article and then inspected the average citations per year of the articles published in the same journal. Such a measure of influence has already been used by some other researchers (see, e.g., Ahmad et al., 2020) and has the advantage of more objective comparisons since it normalises the aspects of the number of publications and the period since the publication. The obtained ranking of the journals, also presented in Table 2.3, differs significantly and shows that the most influential journal is the American Economic Review, with 24 publications, 5,129 total citations, and 17.258 average citations per year. It is followed by the Journal of Economic Perspectives, International Economic Review, and Quarterly Journal of Economics.

Table 2.3: Top 25 most influential journals

Journal	NP	TC		ACY	
		Number	Rank	Number	Rank
Journal of Banking & Finance	189	6,727	1	3.625	17
Journal of Finance	37	5,155	2	11.344	5
American Economic Review	24	5,129	3	17.258	1
Journal of Monetary Economics	67	4,408	4	5.532	12
Journal of Financial Economics	52	4,035	5	8.857	8
Review of Economic Studies	20	3,293	6	10.659	6
Review of Financial Studies	48	3,287	7	9.006	7
Journal of Economic Perspectives	13	2,800	8	15.815	2
Journal of International Economics	24	2,556	9	8.847	9
European Economic Review	45	1,187	10	3.405	18
Journal of Development Economics	36	2,341	11	5.204	13
Journal of International Money and Finance	102	2,105	12	3.017	21
Quarterly Journal of Economics	13	1,827	13	11.743	4
Journal of Financial Intermediation	23	1,738	14	7.144	10
Journal of Economic Dynamics & Control	95	1,681	15	2.446	23
Economic Modelling	149	1,658	16	2.059	24
Journal of Money, Credit, and Banking	57	1,626	17	3.105	20
International Economic Review	7	1,517	18	13.710	3
Journal of Financial Stability	71	1,315	19	3.348	19
Energy Economics	36	1,143	20	6.682	11
International Review of Economics & Finance	71	909	21	2.486	22
International Review of Financial Analysis	56	825	22	4.085	15
Applied Economics	123	734	23	0.889	25
Journal of Financial and Quantitative Analysis	22	688	24	3.787	16
IMF Economic Review	20	679	25	4.205	14

Note: NP – number of publications, TC – total citations, ACY – average citations per year.

Source: Own work.

2.3.4 The most influential contributions

In the last subsection, we present the most important and influential papers based on the number of total citations. Table 2.4 provides the ranking of the top 25 articles with additional information on the publication year and the average citations per year. Based on the total citations, the most influential article is, therefore, 'The Twin Crises: The Causes of Banking and Balance-of-Payments Problems' by Kaminsky and Reinhart (1999), published in the American Economic Review, which has accumulated 1,346 citations. The paper searches for the connections between banking and currency crises and their role in the contractionary and recessionary periods of the business cycles. It is followed by the contributions 'Income-distribution and Macroeconomics' by Galor and Zeira (1993) and 'Answering the Skeptics: Yes, Standard Volatility Models Do Provide Accurate Forecasts' by Andersen and Bollerslev (1998), which have been cited 1,323 and 1,142 times, respectively.

However, when searching for the most influential papers, we must again consider that older papers had more time to accumulate citations, which makes it necessary to look at the obtained average citations per year to rule out the impact of years since publication. From Table 2.4, it is evident that the leading papers according to total citations are, in the case of average citations per year, ranked second, seventh, and fifth, respectively. According to the second criterion, the most influential is 'Deciphering the Liquidity and Credit Crunch 2007–2008' by Brunnermeier (2009), published in the Journal of Economic Perspectives, which has obtained 102.364 average citations per year. The detailed content analysis of the 50 most influential papers, based on the average citations per year, is presented in Section 2.4.

Table 2.4: Top 25 most cited articles

Authors	Title	Journal	Year	TC Number	TC Rank	ACY Number	ACY Rank
Kaminsky G. L.; Reinhart C. M.	The twin crises: The causes of banking and balance-of-payments problems	American Economic Review	1999	1,346	1	64.095	2
Galor O; Zeira J.	Income-distribution and macroeconomics	Review of Economic Studies	1993	1,323	2	49.000	7
Andersen T. G.; Bollerslev T.	Answering the skeptics: Yes, standard volatility models do provide accurate forecasts	International Economic Review	1998	1,142	3	51.909	5
Brunnermeier M. K.	Deciphering the liquidity and credit crunch 2007–2008	Journal of Economic Perspectives	2009	1,126	4	102.364	1
Berger A. N.; Udell G. F.	The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle	Journal of Banking & Finance	1998	1,120	5	50.909	6
Bernanke B. S.; Blinder A. S.	The federal-funds rate and the channels of monetary transmission	American Economic Review	1992	1,120	5	40.000	13
Bernanke B. S.; Gertler M.	Inside the black box: The credit channel of monetary policy transmission	Journal of Economic Perspectives	1995	1,085	7	43.400	9

To be continued

Table 2.4: Top 25 most cited articles (cont.)

Authors	Title	Journal	Year	TC Number	TC Rank	ACY Number	ACY Rank
King R. G.; Levine R.	Finance, entrepreneurship, and growth	Journal of Monetary Economics	1993	1,046	8	38.741	14
Alfaro L.; Chanda A.; Kalemli-Ozcan S.; Sayek S.	FDI and economic growth: The role of local financial markets	Journal of International Economics	2004	673	9	42.063	10
Collin-Dufresne P.; Goldstein R. S.; Martin J. S.	The determinants of credit spread changes	Journal of Finance	2001	659	10	34.684	15
Longstaff F. A.; Mithal S.; Neis E.	Corporate yield spreads: Default risk or liquidity? New evidence from the credit default swap market	Journal of Finance	2005	617	11	41.133	11
Frankel J. A.; Rose A. K.	Currency crashes in emerging markets: An empirical treatment	Journal of International Economics	1996	564	12	23.500	19
Adrian T.; Shin H. S.	Liquidity and leverage	Journal of Financial Intermediation	2010	538	13	53.800	4
Klapper L.; Laeven L.; Rajan R.	Entry regulation as a barrier to entrepreneurship	Journal of Financial Economics	2006	481	14	34.357	16
Gervais S.; Odean T.	Learning to be overconfident	Review of Financial Studies	2001	476	15	25.053	18
Levine R.	Bank-based or market-based financial systems: Which is better?	Journal of Financial Intermediation	2002	422	16	23.444	21
Campbell J. Y.; Taksler G. B.	Equity volatility and corporate bond yields	Journal of Finance	2003	399	17	23.471	20
Andersen T. G.; Bollerslev T; Diebold F. X.; Vega C.	Real-time price discovery in global stock, bond, and foreign exchange markets	Journal of International Economics	2007	387	18	29.769	17

To be continued

Table 2.4: Top 25 most cited articles (cont.)

Authors	Title	Journal	Year	TC Number	TC Rank	ACY Number	ACY Rank
Galor P.; Moav O.	From physical to human capital accumulation: Inequality and the process of development	Review of Economic Studies	2004	373	19	23.313	22
Gilchrist S.; Zakrajšek E.	Credit spreads and business cycle fluctuations	American Economic Review	2012	362	20	45.250	8
Guiso L.; Sapienza P.; Zingales L.	Does local financial development matter?	Quarterly Journal of Economics	2004	353	21	22.063	23
Benabou R.	Unequal societies: Income distribution and the social contract	American Economic Review	2000	352	22	17.600	24
Karolyi G. A.; Stulz R. M.	Why do markets move together? An investigation of us-japan stock return comovements	Journal of Finance	1996	351	23	14.625	25
Brunnermeier M. K.; Sannikov Y.	A macroeconomic model with a financial sector	American Economic Review	2014	334	24	55.667	3
Jermann U.; Quadrini V.	Macroeconomic effects of financial shocks	American Economic Review	2012	328	25	41.000	12

Note: TC – total citations, ACY – average citations per year.

Source: Own work.

2.4 Content analysis of the most influential articles

In this section, we present the content analysis of the most influential papers from the research field on the relationship between the financial and real economy, which were identified based on the average citations per year. In the first subsection, we focus on the presentation of the thematic aspects of the articles; in the second and third subsections, we present the methodology and data used by the authors; and in the last subsection, we present the key contributions of the articles, which had a significant influence on the existing body of knowledge in the observed field. A list of the most influential papers and their overview is provided in Table A1 in Appendix 2.

2.4.1 Thematic analysis

In this subsection, we present the thematic analysis of the top 50 contributions from the field of research on the relationship between the financial and real economy. Due to the nature of the complex relationship between the two, the thematic analysis exhibits a vast spectrum of the research subfields that study the relationship under investigation either directly or indirectly. A possible limitation in the thematic analysis is that attributing the theme to a specific article relies heavily on the subjective judgment of the authors, which comes to light, especially in cases where multiple themes could be assigned.

As expected, the predominant theme in the observed papers is discussing the financial crises and their consequences, representing the central research problem in eight articles. However, several articles have tackled the issue more generally and pinpointed the issue of business cycle fluctuations. The focus on the financial crises to such an extent is also consistent with the results of the bibliometric analysis presented in the previous section, where we discussed the timeline of publications and citations. We showed that such events, which have devastating macroeconomic consequences, have generally stimulated scientific productivity in the observed research field.

In contrast to the previously mentioned group of studies, which focuses on specific events, namely financial crises, several articles investigate the general effects or channels through which the financial market conditions affect the real economy, for example, the finance-growth nexus, effects of financial development or its integration, effects of financial frictions, the importance of financial markets, small business finance, corporate investment, credit spreads, and housing finance. However, these contributions seem to capture the relationship between the financial and real economy more directly, as opposed to another group of studies, which seem to correspond to the research subfield of the stock market volatility and tend to capture the relationship of interest indirectly.

Another critical aspect of capturing the considered relationship is from monetary policy measures. The transmission mechanism of monetary policy is the focal issue investigated by four articles, each of which focuses on different transmission channels and provides some fresh insights into the subject matter. Finally, we have to point out some articles whose main themes do not, at first glance, correspond to the observed research field, namely income distribution, oil price fluctuations, entrepreneurship, business environment, economic views of natural disasters, and growth theory. However, as already mentioned, the investigated relationship is outlined as complex and comes to an effect through various channels; therefore, it is not uncommon to also find evidence of their existence in the articles, whose primary focus lies outside the domain of the observed research field.

2.4.2 Methodology

This subsection presents the methodological aspects of the most influential articles. The most commonly used methodology in the observed papers was the application of econometric time series models, which appeared in 18 studies. Among the extensive collection of distinct models and their specifications, the authors have most frequently used the (structural) vector autoregressive models (9 studies), for example, Gilchrist and Zakrajšek (2012), Bernanke and Gertler (1995), and Baruník and Křehlík (2018). Several articles raised the question of stock market volatility, which is, to a larger extent, investigated by the applications of the GARCH model (5 studies), namely, Guesmi, Saasi, Abid, and Ftiti (2019), Andersen and Bollerslev (1998), and Engle and Rangel (2008).

Due to the extensive usage of the panel data that enables a more consistent estimation of parameters, it is not surprising that the second group of methodological approaches comprises the utilisation of panel regressions, which was the primary choice of the methodology by the authors of 14 articles, for example, Adrian and Shin (2010), Klapper, Laeven, and Rajan (2006), and Gulen and Ion (2016). However, some authors focused on the application of the models, which draw from the economic theory to a greater extent, namely the general equilibrium models (6 studies), e.g., Brunnermeier and Sannikov (2014), Gerali, Neri, Sessa, and Signoretti (2010), and Jermann and Quadrini (2012).

Other methodological approaches, which could be found in the most influential literature from the observed research field and are used less frequently, include the signals approach (Kamnisky & Reinhart, 1999), endogenous growth model (King & Levine, 1993), simultaneous equations modelling (Andersen & Bollerslev, 1998), overlapping-generations model (Galor & Moav, 2004), and agent-based and stock-flow consistent model (Caiani et al., 2016) to name just a few.

2.4.3 Data

In this subsection, we focus on presenting the data used by authors of the most influential papers. The majority of the articles, which also investigate the empirical aspects of the underlying theoretical relationship between the financial and real economy, based the analysis on a sample of multiple countries (21 studies). While most articles focus on investigating economic trends in more than 20 countries, the number of observed countries in the chosen contributions spans from 3 to 109. Moreover, due to the predominant position of the United States in the sense of economic prosperity, size of the internal market, availability of the data, and the development of the financial market, it has become popular to investigate the interactions of the financial and real economy on the U.S. data (16 studies).

Although several studies considered countries as the units of analysis, another popular examination of the underlying relationship between the financial and the real economy is

based on firm-level data. The number of firms observed over time, either financial or non-financial, spans from 5 (Adrian & Shin, 2010) to 3,371,073 (Klapper et al., 2006). Regarding the time frame of the empirical analyses, most of the articles observed the units of analysis for a period longer than a decade; the most prolonged time period considered reached 144 years (Jordà et al., 2016). Accounting for the higher frequencies of the data (i.e., quarterly, monthly, weekly, and daily), the empirical studies typically consider over 100 time periods (commonly denoted by $t = 1, \ldots, T$). The study that observed the units of analysis over the longest period is by Baruník and Křehlík (2018), who observed 4,216 trading days.

2.4.4 Theoretical and empirical contributions

In the last subsection, we present the most important theoretical and empirical contributions by the most influential papers from the observed field. As mentioned in Subsection 2.4.1, the frequently examined research subfield by the observed articles was related to the causes and consequences of financial crises. Although the Great Recession can be regarded as a breakpoint for enhanced scientific productivity, several other financial crises have also gained some scientific interest. For example, Kaminsky and Reinhart (1999) examined 76 currency and 26 banking crises in the 20th century. The link between the two types of crises is established in the recessionary periods, which occur after the economic boom fuelled with credit and capital inflows and results in significant problems in the banking sector. The banking crisis, therefore, precedes the currency crisis, but at that stage, the economy enters a so-called vicious spiral since the currency crises tend to deepen the banking crises even further.

Another point of view on the subject of currency crises is laid out by Frankel and Rose (1996), who observed that the likelihood of the occurrences of currency crises rises in countries with lower output growth, higher levels of domestic credit, and foreign interest rates, and lower foreign direct investments (FDI) to debt ratios. Observing the general aspects of financial crises, Christiano, Motto, and Rostagno (2014) examined the effects of fluctuations in risk and identified them as key contributors to the fluctuations in GDP and other macroeconomic variables. In contrast, Jermann and Quadrini (2012) stressed the influence of the financial frictions and shocks that affected the firms' ability to obtain external financing on the macroeconomic fluctuations and showed that the changes in credit conditions significantly influenced the economic downturns in the early 1990s and early 2000s.

One of the essential research questions was raised by Bekaert, Ehrmann, Fratzscher, and Mehl (2014): 'How and why is the spread of crises across countries and economic sectors so violent?' They provide evidence of the contagion spread of crises, especially to the economies with weak economic fundamentals, poor sovereign ratings, and high fiscal and current account deficits, which was also evident in the aftermath of the Great Recession.

Turning our attention toward the last global financial crisis, Brunnermeier (2009) provided a detailed presentation of the economic mechanisms and events that significantly contributed to the widespread outbreak of a crisis originating in the financial sector. Further investigations of the Great Recession include those by Gerali, Neri, Sessa, and Signoretti (2010), who showed that the largest share of the contraction in the economic activity in 2008 can be attributed to the shocks originating in the banking sector, while the role of macroeconomic shocks was limited, and Gilchrist and Zakrajšek (2012) who provided evidence of the lower capacity of the effective risk-bearing by the financial sector, reflected in an increase in excess bond premium and resulting in lower credit supply, which has severe macroeconomic consequences.

Next, we present the crucial contributions from the group of studies that examined the effects of the general financial market conditions. Guiso, Sapienza, and Zingales (2004) presented evidence of the positive influence of local financial development on local economic performance, even in the case of absent frictions to capital movements, since financial development increases the probability of establishing new companies and promotes their growth. Another aspect of the effects of local financial development was presented by Alfaro, Chanda, Kalemli-Ozcan, and Sayek (2004), who claim that the positive effects of FDI on economic growth can only be realised by ensuring a certain level of development of local financial markets. Moreover, Manova (2013) claims that international trade flows are severely restricted in the presence of financial market imperfections. According to Giuliano and Ruiz-Arranz (2009), the development of the local financial sector also influences countries' capacity to finance investment and overcome liquidity constraints with alternative resources, namely remittances, which tend to increase economic performance in countries with a less developed financial sector.

In contrast, Ouyang and Li (2018) examined the role of the level of financial development in promoting economic growth and energy consumption in the case of China and found that financial development tends to affect the observed variables negatively. Similar conclusions were reached by Arcand, Berkes, and Panizza (2015), who found that as the financial sector size reaches 80–120% of GDP, additional finance negatively affects economic growth. However, as stated by King and Levine (1993), better financial systems increase the probability of innovation and hence boost productivity growth and overall economic development. The consensus of the positive influence of financial development on economic performance, at least to a certain extent, is therefore reached. According to Levine (2002), neither a bank-based nor market-based view of the financial structure could be considered as having a superior role in promoting economic activity.

Another point of view, through which the relationship between the financial and real economy may be established, is concerned with the stock market or equity volatility. The contributions from this subfield include several proposals for new methodological approaches to capture equity volatility and its effects. For example, Andersen and Bollerslev (1998) proposed vastly improved ex-post volatility measurements, which are

based on the cumulative squared intra-day returns, and Phillips, Wu, and Yu (2011) presented a new approach to testing for explosive behaviour in stock prices. The empirical results from this subfield include the contributions by Engle and Rangel (2008), who claim that the main reason for the low-frequency market volatility lies within the long-term volatilities of macroeconomic fundamentals (e.g., GDP and interest rates), Campbell and Taksler (2003), who provided evidence of a direct relationship between the idiosyncratic equity volatility and the corporate bond yields, and Guesmi, Saadi, Abid, and Ftiti (2019), who showed that the virtual currencies (Bitcoin) might offer diversification and hedging benefits for the investors.

Identification of different channels of monetary policy transmission has always been promoted in scientific debates, but it is becoming an even more relevant issue nowadays when central banks use unconventional monetary policy measures. An important strand of literature from the observed research field is concerned with monetary policy transmission. Bernanke and Blinder (1992) showed that monetary policy measures affect the real economy since various measures of economic performance respond to interest rate shocks. Furthermore, they claim that the effects of monetary policy cannot be evident only through bank loans but also through bank deposits.

While Bernanke and Gertler (1995) centred their attention on the presentation of the credit channel of monetary policy transmission, which is characterised as the set of factors that cause the amplification and transmission of the conventional interest rate effects, Borio and Zhu (2012) expressed their concerns regarding the insufficient treatment of the connections between monetary policy and the perception and pricing of risk by the economic agents. In contrast, Gertler and Karadi (2015) investigated the responses of interest rates to policy surprises. They concluded that after a monetary policy shock and observed subtle movements in short rates, the term premia and credit spreads also respond, eventually leading to extensive credit cost fluctuations.

Focusing on the articles, which correspond to various and distinct subfields, we notice that several observed articles pinpointed the issue of measuring the systemic risk of the financial sector. For example, Acharya, Pedersen, Philippon, and Richardson (2017) proposed a simple and intuitive way to measure the contributions to the systemic risk at the bank-level, and Baruník and Křehlík (2018) showed that the connectedness of the financial firms in the U.S. proved to be an effective measure of systemic risk in the financial sector. Since the underlying relationship between the financial and real economy is characterised as highly complex and dynamic, some articles proposed several methodological approaches that could help overcome limitations and provide comprehensive modelling of this relationship. For example, Caiani et al. (2016) proposed a new macroeconomic framework that brings together the agent-based and stock-flow consistent approaches, and Borio (2014) discussed the importance of understanding the financial cycles for the proper modelling of the business cycles and their implications.

2.5 Concluding remarks

In this chapter, we present a systematic overview of the research in the field of the relationship between financial and real economy. The bibliometric methodology enabled us to present the development of the observed research field objectively, including in a historical context. The scientific productivity in the research area started to increase gradually in the early 1990s, but it remained relatively low until the outbreak of the Great Recession (2007–2009). The severe macroeconomic consequences of this financial crisis have significantly increased the scientific community's interest in the underlying interrelationship between the financial and real economy.

The most important contributions of the chapter are the following. Firstly, the search process for the relevant papers was based on the extensive list of keywords drawn from existing literature. Such a selection process ensures higher degrees of objectivity in the analysis and provides a large database of the metadata necessary for the comprehensive bibliometric analysis. Secondly, in addition to the citation analysis, we present the most prolific and influential authors, journals, and articles in the observed research field. Finally, we provide a content analysis of the top 50 most influential articles based on the average citations per year. The content analysis, in the sense of the themes, methodology, data, and contributions, provides some prominent insights into the articles, which can be viewed as scientific breakthroughs in the research field of the relationship between the financial and real economy.

Our analysis yielded several essential findings regarding the observed research field. Firstly, it suggests that the most prolific authors, based on the total citations, are Laeven L., Longstaff F. A., and Adrian T. At the same time, Gallegati M. and Kutan A. M. are considered the most influential authors according to the H-index. Secondly, we identified American Economic Review as the most influential journal, with 24 publications, 5,129 total citations, and 17.258 average citations per year, and The Journal of Banking & Finance as the leading journal in terms of total citations, with 6,727 citations and 189 publications. Thirdly, the contribution, which has accumulated much recognition, is 'Deciphering the Liquidity and Credit Crunch 2007–2008' by Brunnermeier (2009), published in the Journal of Economic Perspectives. Finally, the content analysis of the most influential papers suggests that the predominant theme is the discussion on the financial crises and is followed by investigating the general effects of financial market conditions, stock market volatility, and the transmission of monetary policy.

However, this research is not immune to potential limitations, which are beyond the scope of this analysis and may represent the starting point for further research. Firstly, our database consists of the articles retrieved from the Web of Science Core Collection. Although it is considered a quality database, it may be helpful to combine the data from various sources (e.g., from the Scopus database) to minimise selection bias and comprise a fully embraced database of relevant articles. Secondly, due to the high complexity of the

underlying relationship between the financial and real economy, evidence of their existence can be found in the contributions from various research areas. Therefore, the identification of relevant articles may be based on the further evolved general search term. Thirdly, the quality measure of the articles, journals, and authors is based on the citation counts. However, such a measure is subject to criticism as it does not account for the self and 'negative' citations. Finally, including a higher number of the most influential articles in the content analysis may provide additional insights into the observed research field.

3 THE EFFECTS OF FINANCIAL FRICTIONS ON SLOVENIAN COMPANIES: A PANEL VAR APPROACH

3.1 Introduction

The Great Recession (2007–2009) has renewed the interest of economists and policymakers in understanding the transmission channels between the financial and real economy. Although these channels generally work in both directions, the transmission of the shocks originating in the real sectors to the financial sectors has been accepted as part of the standard macroeconomic theory. Therefore, the crucial channels that intrigue economists in (at least) the previous decade are those which run from the opposite direction. Theoretical literature (Foglia et al., 2011) suggests the existence of three general groups of such channels, which incorporate either the transmission of shocks originating in the financial markets to the real economy or the amplification of the shocks originating in the real economy by the financial markets: the borrower's balance sheet channel, the bank balance sheet channel, and the liquidity channel.

The borrower's balance sheet channel comes to light due to the inability of the financial sectors to evaluate the borrowers' (either households' or companies') creditworthiness fully and promptly and monitor their investment activity, which causes the adjustment in the external finance premium, also as a response to the general macroeconomic conditions. During economic downturns, such adjustments in the costs of external funds directly affect consumption and investment activity, which results in the additional worsening of real economic conditions. In contrast, the bank balance sheet channel occurs when the changes in providing external financing to the borrowers arise from the direct effects of the monetary and regulatory policies on the banks' balance sheets. Finally, the liquidity channel may, on the one hand, serve only to enhance the existing transmission channels or, on the other hand, may reflect additional channels, which arise due to changes in liquidity in financial institutions as a response to monetary policy measures.

This chapter aims to focus on the borrowers' balance sheet channel from the perspective of Slovenian non-financial companies. More precisely, we investigate the impact of imperfect financial markets on business investment. Understanding the determinants (fundamental and financial) of business investment is crucial since they account for roughly 11%

(IMAD, 2023) of the Slovenian GDP. Furthermore, being regarded as the most volatile component of the GDP, investment takes a significant role in business cycles and determines the long-run development of an economy.

More specifically, investment, a pivotal component within national accounts, plays a significant role in initiating or amplifying business cycle fluctuations. The pronounced volatility in investment can be attributed primarily to its forward-looking aspect since investment responds promptly and dramatically to any indications of shifts in forthcoming economic developments (Hassett, 2008). Another contributing factor to the fluctuations in investment stems from the imperfections prevailing in financial markets, leading companies to maintain disproportionately high levels of liquidity. Consequently, investment activity is delayed until periods when adequate financial resources are at their disposal. This phenomenon of retaining liquidity and delaying investment activity subsequently expedites the volatility of the business cycle (Aghion et al., 2010).

On the household front, investment similarly derives from accumulating surplus funds through savings. While individual consumption patterns tend to exhibit stability, household-driven investment is again the category that adjusts to ever-changing economic conditions. Therefore, in the case of households and companies, investment is a forward-looking component generated from accumulated excessive funds, which may vary substantially during the business cycle (Browning & Crossley, 2001).

The significance of investment in the business cycle fluctuations may also be observed in the aftermath of the Great Recession. The global financial crisis severely affected the Slovenian economy and its financial sector. From 2005 to 2008, the economy exhibited significant GDP growth; however, in 2009, the recorded contraction of the economic activity amounted to -7.5%, which was an all-time low since Slovenia declared its independence in 1991. Despite exhibiting a slight recovery during 2010 and 2011, the second wave hit the economy in 2012 and 2013 (regarded as the sovereign debt crisis), when the real GDP growth amounted to -2.6% and -1%, respectively (SiStat Database, 2023). The crisis was marked by a credit crunch, a sharp contraction in lending, a decrease in foreign direct investment, and a sharp increase in nonperforming loans.

For the purpose of this analysis, we collected data from the annual reports of 2,426 Slovenian non-financial companies from 2005 to 2020, provided by the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). Additionally, we also collected data on the average exchange rate and real price of investment from the database of the Statistical Office of the Republic of Slovenia (SORS). Based on the firm-level data on investment rates, debt rate, the marginal productivity of capital, and cash flow rate, we estimated an identified panel VAR model to uncover the effect of financial frictions on business investment.

The rest of the chapter is organised as follows. Section 3.2 outlines the theoretical background and the empirical models used in previous studies. Section 3.3 focuses on the data analysis, including the presentation of descriptive statistics, while Section 3.4 presents the methodology used in this analysis. Finally, the analysis results are presented and discussed in Section 3.5, followed by the concluding remarks of the chapter in Section 3.6.

3.2 Theoretical framework and empirical modelling

In economic literature, a common approach to investigating the existence of the balance sheet channel, or in other words, to evaluate the consequences of invalidity of the Modigliani-Miller assumption of perfect capital markets (Modigliani & Miller, 1958), is to inspect the responsiveness of the business investment to changes in the cash flow of companies, which is a standard proxy for measuring companies creditworthiness (e.g., Fazzari et al., 1988; Angelopoulou & Gibson, 2009; Hovakimian & Hovakimian, 2009). In this section, we primarily focus on the presentation of the theoretical foundations of the balance sheet effects, which will be further upgraded by providing some possible empirical approaches to model them appropriately.

3.2.1 Theoretical framework

In the studies investigating the borrowers' balance sheet channel, the starting point usually draws from the basic neoclassical investment model developed by Hayashi (1982), which, according to Eberly et al. (2008), offers a good benchmark investment model since it efficiently portrays companies' investment behaviour. The outline of the investment model presented below follows Cummins et al. (2006).

The underlying assumption of the model relies on the rational behaviour of companies who seek to maximise the expected discounted value of future payouts to shareholders $V_{i,t}$:

$$V_{i,t} = E_t\left[\sum_{s=0}^{\infty} \beta_{t+s} \prod_{i,t+s}\right] \tag{3.1}$$

where β_{t+s} and $\Pi_{i,t+s}$ present a discount factor and a payout in given periods, respectively. Under the assumption of capital being the only quasi-fixed factor and that variable factors have been maximised out of $\Pi_{i,t+s}$, the payout function can be presented in the following manner:

$$\prod_{i,t}\left(K_{i,t}, I_{i,t}\right) = p_t\left[F\left(K_{i,t}\right) - G\left(K_{i,t}, I_{i,t}\right)\right] - p_t^k I_{i,t} \tag{3.2}$$

where $K_{i,t}$ refers to the companies' stock of capital, $I_{i,t}$ presents gross investment, p_t^k denotes the price of capital goods, p_t refers to the price of the companies' output, and $F(K_{i,t})$ and $G(K_{i,t}, I_{i,t})$ present the production and the adjustment cost functions,

respectively. To derive the final investment equation, we should take into account some further assumptions regarding the production and adjustment cost function, namely that the functions exhibit constant returns to scale, there is perfect competition in all markets, the depreciation rate is constant over time, and that the adjustment costs are quadratic and assume the technological shock $\varepsilon_{i,t}$:

$$G\left(I_{i,t}, K_{i,t}\right) = \frac{b}{2}\left(\frac{I_{i,t}}{K_{i,t}} - a - \varepsilon_{i,t}\right)^2 K_{i,t} \tag{3.3}$$

where a represents a constant, and b stands for the inverse of the slope parameter. Given the above assumptions, the companies' investment behaviour can be summarised by the following standard formulation of the neoclassical investment model:

$$\left(\frac{I}{K}\right)_{i,t} = a + \frac{1}{b}\left[\frac{V_{i,t}}{p_t^k\left(1-\delta\right)K_{i,t-1}} - 1\right]\frac{p_t^k}{p_t} + \varepsilon_{i,t} = a + \frac{1}{b}Q_{i,t} + \varepsilon_{i,t} \tag{3.4}$$

where δ represents the depreciation rate, and $Q_{i,t}$ presents the average q, which is a relation between the total values of companies to the replacement costs of their capital and coincides with the marginal q under the abovementioned assumptions. Therefore, the investment equation (3.4) is based on the assumption of perfect capital markets; however, to test the assumption, the empirical literature usually relies on augmenting the given investment equation by adding additional explanatory variables to capture companies' financial position. The typical approach in such a procedure is to include the companies' current cash flow $CF_{i,t}$ normalised by the current stock of capital $K_{i,t}$, implying that the existence of the financial frictions in the economy is inspected through the lens of the investment-cash flow sensitivity:

$$\left(\frac{I}{K}\right)_{i,t} = a + \frac{1}{b}Q_{i,t} + \gamma\left(\frac{CF}{K}\right)_{i,t} + \varepsilon_{i,t} \tag{3.5}$$

Thus, the key interest lies in inspecting the statistical significance, magnitude, and sign of the estimated coefficient γ. A positive and statistically significant estimate should, in principle, confirm the existence of financial constraints; however, the proxies for measuring the firms' liquidity positions (such as cash flow) may carry some additional information correlated with the fundamental determinants of corporate investment. In addition, as discussed in, for example, the work of Blanchard et al. (1993), the $Q_{i,t}$ is potentially mismeasured, which may arise as a response to the excess stock market volatility. Consequently, the capability of such a measure to efficiently seize the non-financial determinants of the investment opportunities is significantly decreased.

The effects of financial frictions on the real economy can also be examined from a theoretical standpoint. This strand of literature commonly refers to the balance sheet channel as the so-called financial accelerator mechanism, a concept which is attributed to

the contributions of Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke et al. (1999). The latter provides a representative theoretical model with financial frictions based on the dynamic stochastic general equilibrium (DSGE) model, which served as a starting point for numerous studies (see, e.g., Christensen & Dib, 2006; Merola, 2015; Bäurle et al., 2016). However, in this analysis, we focus on presenting the empirical testing of financial frictions, as the theoretical modelling of these frictions falls outside our scope.

3.2.2 Empirical modelling of financial frictions

As mentioned in the previous section, the starting point for a bulk of empirical studies of the balance sheet effects is the augmented investment equation, presented by equation (3.5). However, the issue arises at the appropriate measurement of fundamental determinants, namely $Q_{i,t}$. The investment activity of companies is, to a great extent, based upon the shadow value of the additional unit of capital and, consequently, on the marginal *q*, which reflects the ratio of the expected marginal revenue product of capital to its purchase cost (Bond & Van Reenen, 2007). Moreover, as the marginal *q* is unobservable, the proxies used in empirical studies are typically based on some measurement of the average *q*, also known as Tobin's *q* (Tobin, 1969), which reflects the ratio of the value of companies and the replacement cost of the capital stock.

According to Bond and Van Reenen (2007), despite certain advantages of the Q theory in the sense of explicit modelling of the expectations on the current investment decision-making process and the inclusion of the technological shock, there are also several drawbacks. Most importantly, the criticism usually arises at the basic assumptions, given that perfect competition, the constant return to scale, and the functional form of the adjustment costs may not reflect adequate assumptions. Furthermore, the criticism also tackles the measurement of the marginal *q* based on the stock market data, which may not reflect the real fundamental values. Thus, the fundamental determinants of the investment may not be well accounted for by the measurement of $Q_{i,t}$, since it could be subject to the correlation with the financial variables (e.g., cash flow), which could, in principle, distort the statistical inference on the existence of the balance sheet channel.

As a response to the criticism, Gilchrist and Himmelberg (1995, 1998) developed an empirical method, which is constructed on the basis of a sales-based measure of the marginal productivity of capital (*MPK*). The method, which was included in empirical works of, for example, Love and Zicchino (2006) and Melander et al. (2017), treats the cash flow as a composite of two parts: the first part reflects the pure financial part, while the other part may carry some additional information regarding the investment opportunities. The latter is summarised in the measurement of *MPK*, which is orthogonal to the financial aspects of the cash flow; therefore, the *MPK* should only represent the fundamental determinants of corporate investment behaviour. By construction, the method

is advantageous for inspecting the financial constraints of small companies since it does not rely on the stock market measurements of $Q_{i,t.}$

Focusing on the financial aspect, there is an ongoing debate on whether the investment-cash flow sensitivity[2] provides an appropriate measure of the degree of financial constraints or, more precisely, whether the classification of the companies to groups of financially constrained and unconstrained firms is valid. The influential contribution of Fazzari et al. (1988), who divided the companies according to the respective dividend policies, states that the financially constrained companies exhibit investment-cash flow sensitivities of a larger magnitude.

Numerous studies heavily criticised such results: for example, Kaplan and Zingales (1997) and Hovakimian (2009) provided evidence of the nonmonotonicity of investment-cash flow sensitivity with respect to financial constraints; Gomes (2001) showed that investment-cash flow sensitivities do not meet the necessary nor the sufficient conditions for the financial constraints; Chen and Chen (2012) discussed whether the investment-cash flow still existed in the previous two decades. In contrast, many studies do not contradict the original findings of Fazzari et al. (1988) (see, e.g., Whited (1992), Bond and Meghir (1994), and Fazzari et al. (2000)). In our analysis of investigating the borrowers' balance sheet effects on a case of Slovenia, we follow the latter strand of literature.

3.3 Data

For this analysis, we obtained firm-level data from the annual reports of Slovenian companies (excluding sole proprietors) provided by the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). Such a large dataset carries at least two advantages regarding the assessment of the existence of the balance sheet channel. First, we are observing Slovenian companies over a relatively long period, including a significant economic downturn in light of the global financial crisis, which potentially decreased companies' access to external financing. Second, unlike several previous studies, which focus on examining the balance sheet channel on large publicly traded firms (e.g., Gilchrist & Himmelberg, 1995; Bond et al., 2005), our dataset includes a large set of small firms, for which the effects of financial frictions are potentially more binding (Kadapakkam et al., 1998). The data preparation process consisted of several steps: 1) merging the information from the annual reports from between 2006 and 2020, 2) calculating the variables of interest, 3) cleaning the dataset, and 4) presenting descriptive statistics.

Merging the information from the annual reports during the period of 2006–2020. In the first step, we focused on joining the information from the annual reports into a single dataset. Although the availability of the annual reports spans from 1994 onwards, we

[2] See, e.g., Hubbard (1998) for additional literature on empirical testing of financial frictions.

choose to disregard the period from 1994 to 2004 in our analysis, as the information available in the reports is greatly limited, which does not allow for calculating the variables of interest. Annual reports consist of the income statements and the balance sheets for each accounting period that coincides with the calendar year. Since the annual reports for each year also include the accounting data for the previous year, this served as a benchmark for merging the separate datasets into one, and we also utilised the data referring to the year 2005 in our analysis.

Due to the Slovenian adoption of the euro currency on 1 January 2007, we have also transformed the values corresponding to the accounting year 2006 into euro-denominated values, using the average annual exchange rate. After joining the annual databases and deleting some outliers (e.g., excluding firms, which were taken into account twice in a given year), we obtained a single large dataset of more than 870,000 firm-year observations. However, the dataset also contained the accounting information of a large sample of micro firms (with less than five employees), for which we could not calculate the variables of interest due to limited information corresponding to limited business activity. Therefore, we chose to exclude them from the final sample in this step; hence, the dataset from the first step consists of 167,237 firm-year observations.

Calculating the variables of interest. In the second step, we focused on defining the variables of interest, namely investment rate (*I*), debt rate (*D_tot*), long-term debt rate (*D_lr*), the marginal productivity of capital (*MPK*), and cash flow rate (*CF*). All original variables from the annual reports are expressed in euros. However, for the purpose of the analysis, we normalise the variables of interest by the total tangible assets (taken at the end of the previous year), which serve as an approximation for capital stock. These variables are calculated in the following way:

– As opposed to the investment (*Inv*, expressed in EUR), investment rate (*I*) denotes an investment-to-capital ratio and is calculated based on the perpetual inventory method:

$$K_{i,t} = (1-\delta_{i,t})K_{i,t-1} + Inv_{i,t} \tag{3.6}$$

  implying that *I* is calculated in the following way:

$$I_{i,t} = \frac{K_{i,t} - K_{i,t-1} + \Delta_{i,t}}{K_{i,t-1}} \tag{3.7}$$

  where $K_{i,t}$ represents the total tangible fixed assets (AOP010), $\delta_{i,t}$ represents depreciation and amortisation rate (depreciation and amortisation expense (AOP145) divided by approximation of capital stock), and $\Delta_{i,t}$ represents depreciation and amortisation expense (AOP145).
– Debt rate (*D_tot*) is expressed as a debt-to-capital ratio, where the debt is defined as the average outstanding long-term financial and operating liabilities (AOP076+AOP080)

and short-term financial and operating liabilities (AOP087+AOP091) in the current year.

- Long-term debt rate (*D_lr*) is expressed as a long-term debt-to-capital ratio, where the long-term debt is defined as the average outstanding long-term financial and operating liabilities (AOP076+AOP080) in the current year.
- The marginal productivity of capital (*MPK*) is defined as a measurement that should take into account the fundamental determinants of investment and, therefore, should not hold any information on the financial aspects of investment decisions. Such a measure ensures the incorporation of the equilibrium condition, stating the equality between the marginal benefit and marginal cost of the additional unit of capital. Gilchrist and Himmelberg (1998) have proposed a similar measure of controlling for fundamentals in studying the investment-cash flow sensitivities. In our case, the user cost of capital is defined by equation (3.8) (following Angelini et al., 2019), and we assumed it as a proxy of the marginal productivity of capital, thus:

$$MPK = RP_{t-1}\left(R_{i,t} + \delta_{i,t} - (1-\delta_{i,t})\left(\frac{RP_t - RP_{t-1}}{RP_{t-1}} \right) \right) \tag{3.8}$$

  where RP_t presents the real price of the investment obtained from the database of the Statistical Office of the Republic of Slovenia (SORS), and $R_{i,t}$ presents an approximation for the corporate investment rate, calculated as the ratio between financial expenses for interest (AOP167) and the total debt (*D_tot*). It is worth noting that our measure does not account for the adjustment costs and partially relies on macroeconomic variables under the assumption of some homogeneity across companies.
- The cash flow rate (*CF*) is expressed as a cash flow to capital ratio, where the cash flow is obtained by adding the depreciation and amortisation expense (AOP145) to the reported operating profit/loss (AOP151/AOP152).

Cleaning the dataset. In this step, we primarily restricted the sample to include only Slovenian non-financial companies, which decreased the sample size to 133,883 firm-year observations. However, in light of previous studies (e.g., Gilchrist & Himmelberg, 1995; Guariglia, 1999; Shcherbakov, 2022), we decided to primarily focus on manufacturing companies since the measurement of capital and investment should be more reliable; we provide the results of the analysis based on the overall sample of non-financial companies as a sensitivity analysis. Consequently, the sample size further dropped to 41,688 firm-year observations.

Next, we further restricted our sample to include only manufacturing companies with at least 15 employees, which is slightly less restrictive compared to the criterion used by Melander et al. (2017), which was set at companies with at least 20 employees in a given year. Such restriction ensures examining a more stable sample of companies observed over

a prolonged period of time, especially during a turbulent economic climate, when we may observe an increased number of bankruptcies and defaults of (particularly) small firms. Next, since we are interested in the effects of the potential existence of the balance sheet channel across firms, we divided the sample of companies into two groups by taking the size of the companies, based on the number of employees, as the sample-split indicator. The sample split is determined from the 75^{th} percentile (97 employees) of the distribution of the number of employees, which is broadly in line with the study of Gilchrist and Himmelberg (1998), who decided to define large companies by the upper third of the distribution regarding the number of employees; however, for the case of Slovenia, such a split would imply only a small number of large companies.

It is worth noting that the additional indicators, which may commonly serve as determinants for identifying financially constrained companies, include factors such as the age of the companies (Devereux & Schiantarelli, 1990), dividend payouts (Fazzari et al., 1988), asset tangibility (Almeida & Campello, 2007), profitability, leverage, and sales growth (Whited & Wu, 2006). Although alternative proxies of financial constraints are intuitive, most researchers in the literature choose companies' size as an ultimate measure of financial constraints due to the good availability of data, which is an important factor for analysis in countries where the financial market tends to be smaller and less developed.

In addition to deleting the observations with missing values, we further trimmed the outliers to avoid biased results. More precisely, we excluded the upper and lower 1% of observations for each variable separately, as proposed by similar studies (e.g., Chirinko et al. (1999)). Hence, we obtained our final sample, which is defined as the unbalanced panel and consists of 17,474 firm-year observations. The significant reduction in the sample size corresponds mostly to restrictions regarding the specific sector and size of companies based on the number of employees; however, the reduction of the sample seems to be in line with several other studies (e.g., Schoder (2013) and Melander et al. (2017)). Finally, we have also decided to inspect the potential existence of the balance sheet channel during the two subperiods; the first corresponds to the period primarily driven by the financial crisis (2006–2012), while the second subperiod considers the period of economic recovery.

Presentation of descriptive statistics. In the final step, we present the descriptive statistics of the variables of interest in Table 3.1. It is evident from the table that we take into consideration 2,426 Slovenian manufacturing firms, with the average number of employees standing at 117.26, which sheds light on the economic structure of the Slovenian economy, where we observe a large number of relatively small companies. Given the sample size, it is evident that, on average, we observe each company for approximately 7.2 years. From comparing the investment and cash flow rates, we may already observe the differences between small and large companies since the rates tend to be higher for small companies during the observed period.

Table 3.1: Summary statistics of the variables included in the baseline analysis

Sample	Variable	Mean	Std. deviation	Percentiles			Firm-year observations			Number of companies	Average number of employees
				25th	Median	75th	Total sample	Subsample 2006-2012	Subsample 2013-2020		
All companies	I	0.29	0.64	0.04	0.12	0.30	17,474	7,967	9,507	2,426	117.26
	D_tot	0.11	0.71	-0.10	0.00	0.13					
	MPK	0.14	0.14	0.11	0.16	0.24					
	CF	0.81	0.81	0.14	0.25	0.45					
Large companies	I	0.20	0.29	0.05	0.12	0.26	4,350	2,194	2,156	441	351.77
	D_tot	0.04	0.34	-0.21	-0.09	0.00					
	MPK	0.18	0.10	0.12	0.16	0.20					
	CF	0.31	0.42	0.13	0.23	0.38					
Small companies	I	0.32	0.72	0.03	0.12	0.32	13,124	5,773	7,351	1,985	39.53
	D_tot	0.13	0.79	-0.10	0.00	0.14					
	MPK	0.20	0.15	0.11	0.16	0.25					
	CF	0.44	0.90	0.14	0.26	0.48					

Note: I – investment rate (investment-to-capital ratio), D_tot – debt rate (total debt-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio).

Sources: AJPES, own work.

3.4 Methodology

In this analysis, we employ the panel vector autoregressive (VAR) approach, using the R package *panelvar* (Sigmund & Ferstl, 2021).[3] Although presented to the economic literature by the seminal work of Holtz-Eakin et al. in 1988, studies incorporating such an approach are still relatively scarce, at least when compared to the usage of the traditional VAR approach. It can be inferred that the panel VAR methodology utilises two elements: first, it employs the traditional VAR methodology (introduced into econometric literature by Sims, 1980), where the variables are treated as endogenous; secondly, it takes advantage of the benefits of the panel data methodology, granting the opportunity to account for the unobserved individual heterogeneity.

Prior to the estimation, we checked the stationarity of the main variables. Based on the Im–Pesaran–Shin test (Im et al., 2003) and Fisher-type tests, which both grant the opportunity to test the presence of the unit roots in the unbalanced panels, we may conclude that all the variables in the model are stationary.[4] In the estimation procedure, we follow Gilchrist and Himmelberg (1998) to a certain extent; however, we chose to add a variable, namely debt rate (*D_tot*), to account for the additional source of financing, which can arise from the supply side of the financial sector. Building from the theoretical foundation presented in Section 3.2, specifically equation (3.5), we included the debt rate, denoted by $(D/K)_{i,t}$, in the equation to test the presence of spillover effects through the credit market:

$$\left(\frac{I}{K}\right)_{i,t} = a + \frac{1}{b}Q_{i,t} + \gamma_1\left(\frac{CF}{K}\right)_{i,t} + \gamma_2\left(\frac{D}{K}\right)_{i,t} + \varepsilon_{i,t} \tag{3.9}$$

Hence, we are interested in the statistical significance of coefficients γ_1 and γ_2. Previous studies (e.g., Melander et al. (2017)) found a significant effect of a cash flow shock on business investment. However, they did not test the presence and significance of the credit channel. Therefore, we enhance the approach by controlling for the debt rate endogenously within the model to test for the presence of a credit constraints transmission channel.

The reduced-form panel VAR model takes the following form:

$$y_{i,t} = \mu_i + \sum_{l=1}^{p} A_l y_{i,t-l} + \alpha_t + \varepsilon_{i,t} \tag{3.10}$$

where A_l represents the matrix of coefficients, $y_{i,t}$ presents a *4 x 1* vector of endogenous variables, namely the investment rate $I_{i,t}$, debt rate $D\_tot_{i,t}$, the marginal productivity of capital $MPK_{i,t}$, and cash flow rate $CF_{i,t}$:

[3] Canova and Ciccarelli (2013) provide an extensive survey on the panel VAR methodology.
[4] The results of the tests are reported in Appendix 3.

$$y_{i,t} = \begin{bmatrix} I_{i,t} \\ D\_tot_{i,t} \\ MPK_{i,t} \\ CF_{i,t} \end{bmatrix} \tag{3.11}$$

and μ_i and α_t refer to the firm-specific and time-specific effects, respectively. $\varepsilon_{i,t}$ represents the reduced-form disturbances that are independently and identically distributed (i.i.d.) for all i and t and are assumed to be the combinations of the underlying structural shocks $v_{i,t,}$ which are identified by the Cholesky decomposition.[5]

By construction, the ordering of the variables follows the rule of increased endogeneity, such that the variables in the system which are placed first affect the subsequent variables both contemporaneously and with lag effects, while the variables located later in the sequence will only affect the preceding variables through the lag effect (Lütkepohl & Krätzig, 2004). Therefore, the ordering of the variables presented above explicitly states the assumption of the contemporaneous effects of the investment rate shocks on the rest of the variables in the system while presuming that the corporate investment decisions do not have an instantaneous response to changes in economic and financial conditions. Conversely, the cash flow rate shocks tend to affect the remainder of the variables only through lag effects. The latter is crucial for investigating the existence of the balance sheet channel, owing to the fact that the cash flow rate should not affect the current values of the fundamental determinants of investment rates captured by the *MPK*.

The model is estimated by the two-step generalised method of moments (GMM) procedure, which takes into consideration the Windmeijer (2005) finite-sample correction. While the time-specific effects are accounted for by the inclusion of the year dummy variables, the firm-specific effects are accounted for by using the forward orthogonal deviations (FOD) transformation (or Helmert transformation), introduced by the seminal paper of Arellano and Bover (1995). The FOD transformation was introduced as a response to certain drawbacks of the first differences (FD) transformation. Unlike FD, which subtracts past observations from each data point, FOD subtracts the average of all future observations instead, which helps minimise the amount of information lost and ensures that past observations remain usable as instruments. Thus, only the most recent observation may not be used in the estimation process, which (along with the VAR order) causes the decreased number of firm-year observations in the final estimation sample. According to Baltagi (2008), the applied transformation and use of lagged instruments effectively tackle the issue of the firm-specific effects and ensure consistency of the obtained estimates when confronted with the so-called short panels (small T, large N).

[5] The identification matrix is obtained by calculating the Cholesky decomposition of the variance-covariance matrix of the reduced-form residuals.

In addition to the estimation results of the GMM regressions, it is also necessary to provide some specification tests, such as the Hansen overidentification test for the validity of instrument subsets, stability of the panel VAR model, and the Andrews-Lu model and moment selection criteria (MMSC). The Hansen overidentification test (Hansen, 1982), which can only be applied to the overidentified specification of the model, postulates an inference regarding the validity of the instrumentation strategy. The second test refers to the standard criterion stating that the stability of the VAR model is validated if the moduli of the companion matrix are strictly less than one (Hamilton, 1994). The MMSC are the extended forms of the well-known selection criteria, which can be used in the context of the panel VAR methodology (Andrews & Lu, 2001). General guidelines regarding the model specification suggest the supremacy of the MMSC-BIC (Bayesian information criterion) or the MMSC-HQIC (Hannan-Quinn information criterion) over the MMSC-AIC (Akaike information criterion) as the latter does not fulfil the consistency criterion (Sigmund & Ferstl, 2021).

3.5 Results

This section discusses the main empirical results of the identified panel VAR model presented in the previous section. Based on the Andrews-Lu model and moment selection criteria (MMSC-BIC and MMSC-HQIC), the suggested lag order is 1.[6] We estimated the impulse response functions to four structural shocks for different baseline specifications of the model. The first specification includes all available observations, and the second builds upon baseline results by decomposing the dataset into a subsample of large companies, which are presumed to be less financially constrained, and a subsample of small companies, for which we assume that are bounded by the financial constraints more severely. Furthermore, we split the dataset into subsamples based on the time dimension. The first subsample concentrates on the period from 2006 to 2012 and includes the financial crisis and a significant part of the sovereign debt crisis. The second subsample, in contrast, concentrates on the period after the crisis (from 2013 to 2020). Additionally, we present the results of the robustness checks stemming from the estimation of different variations of the baseline specifications.

The baseline impulse response functions based on the entire sample of companies are presented in Figure 3.1. A unit cash flow shock affects the business investment rate, which remains statistically significantly elevated for three years after the initial shock. The business investment rate increased by approximately 0.18 p.p. during the first year after the shock. We can interpret those results by accounting for the fact that the change in the cash flow is invariant to changes in capital. Thus, an increase in the cash flow by 1 EUR is expected to increase the company's investment by 0.18 EUR, on average. The response of the *MPK* is modest and statistically significant only in the first year after the shock. This means that the fundamental investment function is only marginally affected by the cash

[6] The results of the MMSC are reported in Appendix 4.

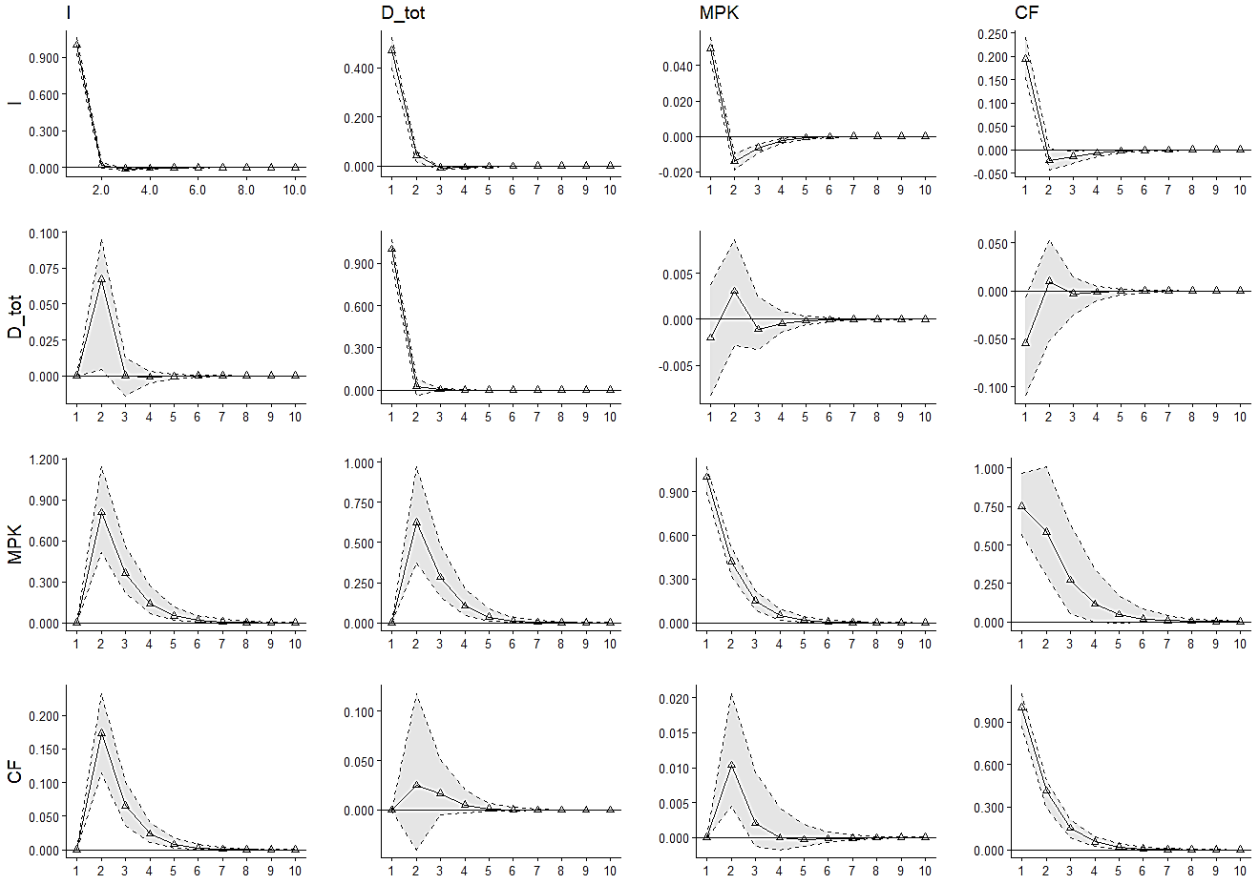
flow shock. The company's debt rate response is positive but statistically insignificant in the aggregate sample. This result points to the conclusion that companies in Slovenia are, in the aggregate, not financially constrained from the perspective of the company's accessibility to external financing in the form of financial debt. The effect on investment through the cash flow could, therefore, be affected by other factors. However, we will test this phenomenon on several model specifications to shed some light on it from the perspective of the specific size classes of the companies as well as various periods.

The *MPK* shock significantly increases the company's investment as well as its debt ratio. Such a result is expected as the shift in capital productivity will likely influence companies' investment decisions independently of the current financial situation. It is evident that the *MPK* shock simultaneously increases the company's cash flow; hence, it is essential to control for the *MPK* when studying the balance sheet effects on the business investment rate.

Figure 3.2 presents similar impulse response functions to Figure 3.1, except for the disaggregation of the sample to the subsets of small and large companies. Comparing the results of the cash flow shock to results from the basic aggregate specification, we can observe that a small company's investment rate is affected relatively more compared to large companies. However, the debt rate response is similar for both sizes of the companies, pointing once again to the conclusion that some other factors, unrelated to the credit constraints, are responsible for the significant transmission of the cash flow shocks to the investment rate. However, it is worth noting that the investment rate response for the big companies is statistically insignificant, showing that the balance sheet effects are prevalent, especially in the case of smaller companies.

Furthermore, we estimate the impact of the balance sheet effects on investment for the case of two subsamples, namely the period from 2006 to 2012 that contains the financial crisis and the sovereign debt crisis and the period between 2013 and 2020 that can generally be characterised as a period of relatively solid growth. Impulse response functions related to those subsamples are presented in Figures 3.3 and 3.4. Between 2006 and 2012, the balance sheet effects were significantly amplified in the case of both big and small companies. The response of the investment rate of big companies is statistically significant and similar in magnitude to the one of small companies. Furthermore, small companies experienced a statistically significant effect of credit constraints in the period of the financial crisis, although this effect seems to be muted in the aggregated sample. The result is consistent with the study by Črnigoj and Verbič (2014), who investigated the financial constraints of Slovenian companies during the financial and economic crisis. During the period from 2013 to 2020, we again observe balance sheet effects only in the case of small companies. The responses to the cash flow shock related to large companies are, on the other hand, statistically insignificant. Nevertheless, we can observe that the median impulse response of debt rate is negative for large companies, indicating an aggregate decrease in debt levels as internal funds largely finance the business investment.

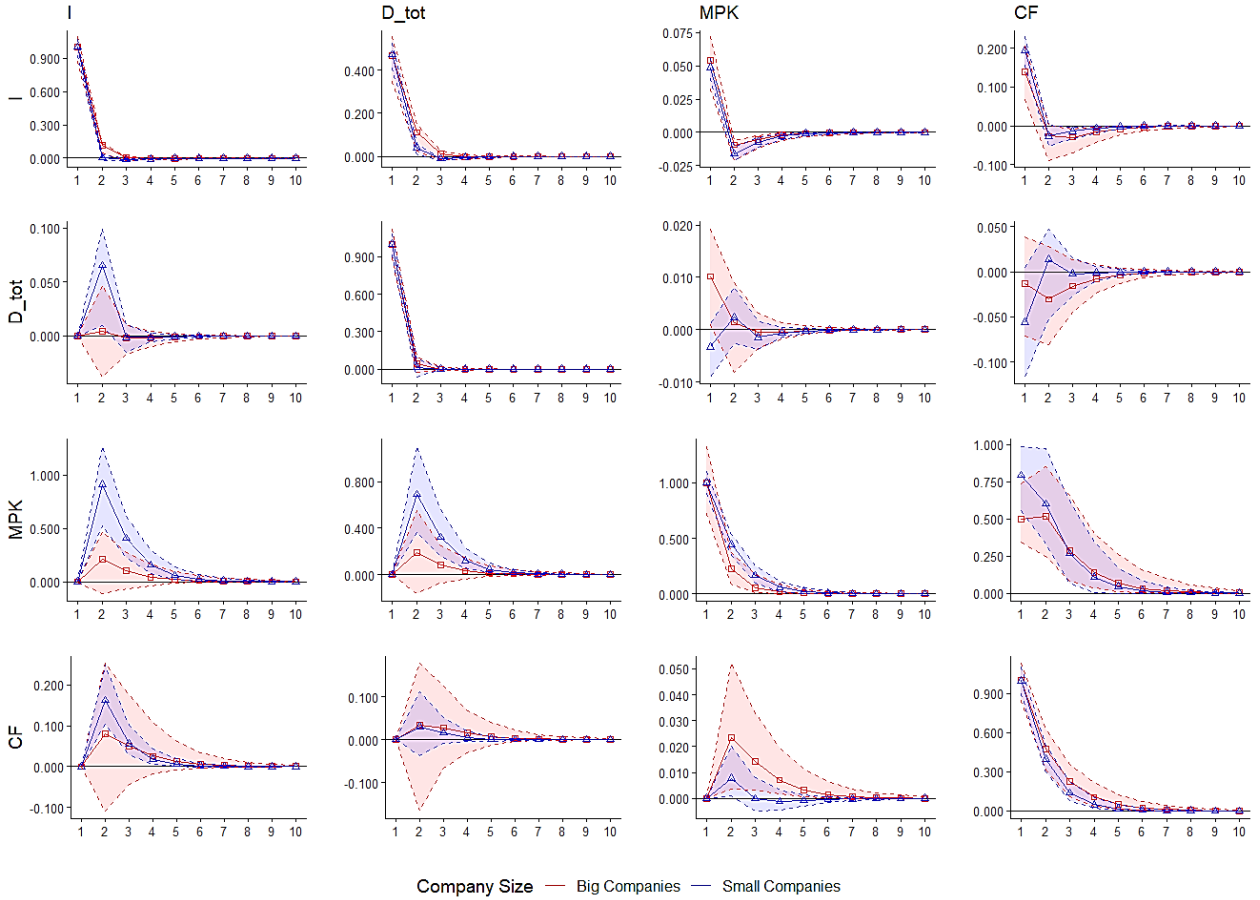
Figure 3.1: Impulse response for all companies



Note: I – investment rate (investment-to-capital ratio), D_tot – debt rate (total debt-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws.

Sources: AJPES, own work.

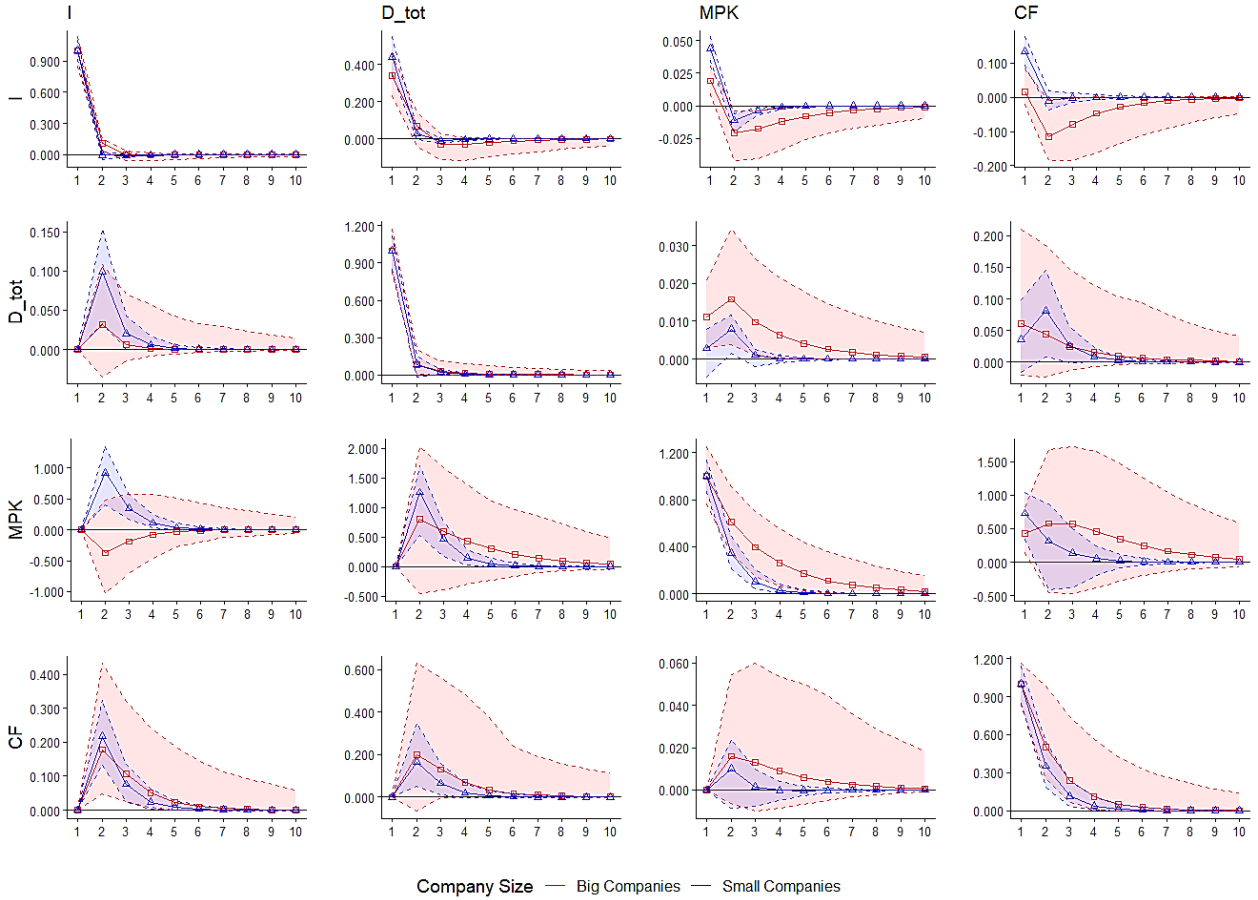
Figure 3.2: Impulse responses for the two groups of companies



Note: I – investment rate (investment-to-capital ratio), D_tot – debt rate (total debt-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws.

Sources: AJPES, own work.

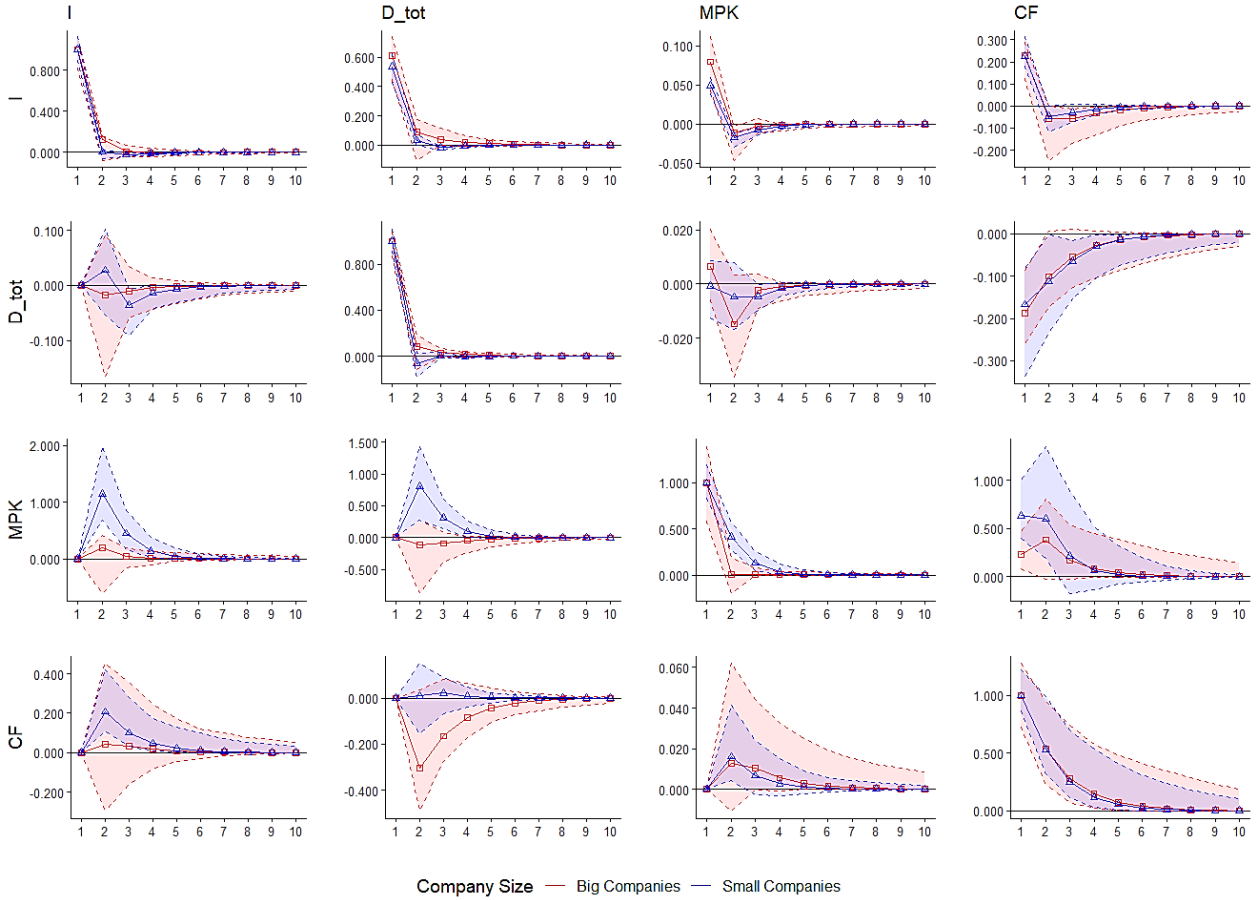
Figure 3.3: Impulse responses for the subperiod 2006–2012



Note: I – investment rate (investment-to-capital ratio), D_tot – debt rate (total debt-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws.

Sources: AJPES, own work.

Figure 3.4: Impulse responses for the subperiod 2013–2020



Note: I – investment rate (investment-to-capital ratio), D_tot – debt rate (total debt-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws.

Sources: AJPES, own work.

The tables containing the respective estimates of coefficients are available in Appendix 4.[7] Supplementary to the estimates, we also report the results of the specification tests mentioned in the previous section. The tests indicate the stability of the panel VAR for all specifications and the validity of the instrumentation strategy based on the Hansen (1982) test for the majority of the specifications (the only exception is the specification, which takes into account large companies during the subperiod 2013–2020).

We checked the robustness of our results by estimating different model specifications and comparing their results with our main specifications presented above. Specifically, we controlled for the robustness concerning the ordering of variables and the lag order (we included two lags instead of one). Additionally, we included non-financial companies from other sectors (not only manufacturing) and replaced the debt rate in the model with the long-term debt rate. Our main result of the balance sheet effects on the investment remains robust throughout those specifications. Impulse responses, along with the estimated coefficients and the results of the specification tests related to the robustness checks, are available in Appendix 5.

3.6 Concluding remarks

In this chapter, we investigate the existence of the borrowers' balance sheet effects on the sample of Slovenian non-financial companies. More precisely, we investigate the transmission mechanism of indebtedness, which may represent one of the fundamental rigidities that may alter the investment activity during a period of financial distress. For this analysis, we utilised the data from the annual reports of 2,426 Slovenian non-financial companies from 2005 to 2020 (17,474 firm-year observations) provided by the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). Firm-level data on investment rates, debt rate, the marginal productivity of capital, and cash flow rate enable estimating an identified panel VAR model to uncover the effect of financial frictions on business investment.

More precisely, we investigate the impact of imperfect financial markets on business investment. Understanding the determinants of business investment is crucial since it accounts for a significant share of the Slovenian GDP and is simultaneously regarded as the most volatile component of the GDP. Furthermore, business investment plays an important role in business cycles and determines the long-run development of an economy.

Our results suggest that the balance sheet effects are present in the whole sample of Slovenian non-financial companies. However, in the entire sample, we could not conclude that the transmission mechanism runs through the loan availability as the debt rate remains intact. Going forward, we decomposed our sample via size dimension into large

[7] Although included in the model specification, the estimates of the yearly dummy variables are not reported due to space limitations.

(financially unconstrained) and small (financially constrained) non-financial companies. Furthermore, we divided out the sample via time dimension on the period of adverse economic conditions (2006–2012) and the period of moderate economic prosperity (2013–2020). We used subsamples to shed some light on the mechanisms that may be relevant, especially for financially constrained companies during the period of financial distress.

Our results confirm those assumptions as financially constrained companies experience a significant response in indebtedness due to their cash flow shock only in periods of low economic growth. No such conclusions could be drawn for financially unconstrained companies. These results imply that the transmission of credit supply is only significant for financially constrained companies during periods of adverse economic conditions. Consequently, policymakers should prioritise implementing certain measures to ensure the availability of external financing and mitigate the negative impacts of reduced economic activity on business performance during economic downturns. Such measures may involve collaboration between the government and financial institutions to facilitate lending and provide guarantees, insurance schemes, or targeted financial support for financially constrained companies, such as low-interest loans, grants, or tax incentives.

Our analysis has presented evidence supporting that balance sheet effects encompass a broader range of factors operating through diverse transmission channels. Future research should prioritise exploring these channels to obtain insights into the underlying determinants of business investment in Slovenia and its financing sources, moving beyond the conventional understanding of credit supply and demand dynamics. While our findings offer some understanding of the investment behaviour of Slovenian companies, suggesting that the relatively low investment rate over the past decade is not greatly attributed to external financing constraints, it is important to acknowledge the limitations of this analysis. Specifically, we have not accounted for the potential liquidity preferences of companies and have yet to incorporate an assessment of the risks associated with investment activities and their financing sources. However, these limitations fall outside the scope of this analysis and should be addressed in future research, likely adopting a macroeconomic perspective.

4 UNRAVELING THE CREDIT MARKET SHOCKS AND INVESTMENT DYNAMICS: A THEORETICAL AND EMPIRICAL PERSPECTIVE

4.1 Introduction

The credit market can significantly affect the business investment performance, especially during periods of economic distress. In this chapter, we investigate the underlying credit market shocks that historically affected business investment in the small open economy of

Slovenia. In contrast to the existing literature, we explored more profound structural shocks beneath the credit demand and supply shocks. For the purpose of structural identification, we propose a theoretical model that outlines our set of structural equations, further evaluated with the structural Bayesian vector autoregressive (BVAR) model.

During the tremendous financial and debt crises (2008–2013), business investment in Slovenia suffered a severe decline. While a major share of the fall can be attributed to the general economic conditions and high uncertainty, some studies have shown that credit market shocks contributed significantly to the overall decline (e.g., Helbling et al., 2011; Meeks, 2012). Adverse loan supply shocks can emerge from the elevated risk on the financial market, as well as shifts in the bank profit function. Similarly, we argue that loan demand shocks, emerging from liquidity demand, can negatively affect business investment. The introduction of the liquidity demand shock in the structural VAR setting is an innovation rooted in the context of imperfect capital markets, for which we assume that liquidity holdings are a necessary buffer that protects the firm in an uncertain environment. In this context, we identify four shocks that lie beneath the general credit market shocks. The loan supply curve is affected by the credit risk shock and the banks' profit function shock, while the loan demand curve is affected by the liquidity demand shock and investment demand shock. Lack of funding availability for investment can also be reflected in the demand side of the credit market. In our theoretical setting, liquidity demand is triggered by the firms' anticipation of future funding needs that the credit supply may not meet.

Sign restriction identification of structural shocks is based on the theoretical model of imperfect capital markets, for which we outline the reasoning behind the choice of signs. Our theoretical model is characterised as a partial equilibrium three-period model of final goods producers and a banking sector. In every period, goods producers are affected by an uncertain production shock. As the capital markets are imperfect, available funding often deviates from the necessary funds to ensure firms' optimal investment; therefore, the firm is incentivised to hold some liquidity reserves that allow them to move closer to the optimal investment in the case of low production shock. We include two types of credit market imperfections: 1) banks' expected profit function, which is concave in the outstanding amount of loans; and 2) banks' notion of uncertainty, which amplifies the probability of a low return event as they do not directly observe the producers' shock distribution.

The remainder of the chapter is structured as follows. Section 4.2 presents our theoretical framework to uncover the underlying changes that can affect the credit market and investment. In Section 4.3, we present our empirical framework based on the sign restriction identified Bayesian VAR model. In Subsection 4.3.1, we present the main methodological properties of the Bayesian VAR models. We continue in Subsection 4.3.2 with the data description and empirical specification of the Bayesian VAR model. In subsections 4.3.3 and 4.3.4, we discuss the sign restriction identification procedure. Our

empirical results are shown in Section 4.4 in the form of impulse response functions, forecast error variance decompositions and the historical decomposition of business investment in Slovenia. Finally, Section 4.5 summarises the main theoretical and empirical findings.

4.2 Theoretical framework

In this section, we present the theoretical framework that allows us to form the reasoning behind the loan demand and loan supply functions in the credit market. Specifically, we shed some light on the loans to non-financial firms, which are meant to be used for investment purposes or bridging liquidity demand. With explicit theoretical representation, we aim to explain the transmission channels of the underlying shocks that lead to the changes in the loan supply and loan demand curves. In the economic literature, an unexpected shift in the loan supply or demand curve is commonly described as an economic shock itself. In this chapter, we present an alternative explanation emphasising the underlying structural shocks reflected in the credit market. Furthermore, we implicitly claim that the loan demand and supply shocks are not fundamental, as, according to our model, they merely reflect other structural shocks.

The theoretical model aims to provide a background to the empirical identification of structural shocks that lie beneath the commonly propagated design of the loan supply/demand setting. In that spirit, we abstain from the general equilibrium definition of the model as we only describe the sources of disequilibrium in the credit market. For this purpose, we define two types of economic agents, firms and banks, while households' decisions are not included in the analysis.[8]

4.2.1 Related literature

Our theoretical framework is rooted in the theory of credit rationing, asymmetric information, and the corporate liquidity theory. Information asymmetry and its effects on the credit market are theoretically well-explored phenomena. An early contribution to this field of theory was made by Hodgman (1960), who tried to explain the persistence of credit rationing in the equilibrium. His theory is based on the notion that the maximal possible revenue determines the borrowers' ability to repay the debt. Thus, there is no reason for a bank to lend the amount that would (together with relevant costs) exceed the maximal possible revenue. In other words, Hodgman (1960) noted that the credit supply curve becomes increasingly inelastic to higher amounts of outstanding loans. The theory of Freimer and Gordon (1965) provides an even stronger assumption regarding credit rationing. They argued that the loan supply function is increasing in the lending rate only up to a certain point. At that point, the curve becomes inverted as the potential losses can

[8] Households' savings provide the basis for the credit market in most general equilibrium models. In this setting, we assume a stock of deposits as an initial endowment of the economy.

no longer be compensated with a higher lending rate. Jaffee and Modigliani (1969) improve the theoretical structure by allowing the endogenous adjustment of the lending rate and simultaneous modelling of credit supply and demand. They note that credit rationing occurs only in the low-interest rate environment. Credit rationing theory benefited significantly from the introduction of information asymmetries by Akerlof (1970), whose theory is rooted in the notion of asymmetries of information attained by the lender.

Consequently, banks may be more cautious in their investment decisions by leaning towards more negative realisations. The introduction of the principal-agent approach to credit markets is an important contribution to the financial accelerator theory, as noted by Bernanke et al. (1996, 1999). Akerlof's (1970) idea was extended in the model of Stiglitz and Weiss (1981). Their model takes into account the increased risk associated with the increasing interest rate, meaning that the lenders' expected return increases less in a high lending rate territory. The information asymmetry is further addressed by Williamson (1986, 1987), who emphasised the importance of monitoring the firms' behaviour.

Discussion of the issue of liquidity management in the context of imperfect financial markets goes back to Keynes (1936). However, the existing literature on the theory of firm liquidity management is limited, with few noteworthy contributions, including but not limited to Kim et al. (1998), Almeida et al. (2002, 2014), and Anderson and Caverhill (2005). Within the context of this chapter, we primarily follow the conceptual framework proposed by Kim et al. (1998), who study the firms' optimisation problem augmented by the liquidity-holding decision. Their theory is settled between the theoretical model of Myers and Majluf (1984), who argued that firms should finance their investment exclusively through internal funds as they did not assume any offsetting costs of the liquid assets, and Jensen (1986) who argued that firms would optimally carry no liquid assets. We adapted the theoretical framework of Kim et al. (1998) with some changes that allow the firm to contemporaneously choose the investment in capital, investment in liquidity, and amount of loans.

4.2.2 Description of the model[9]

Our theoretical representation of the credit market model is an extended version of Kim et al. (1998) three-period model, whose contribution aims to explain the trade-off between firms' investment in liquidity and production from the perspective of firms. Furthermore, they assume that the return on bank loans is endogenously determined so that banks are compensated for the risk and that the notion of uncertainty for firms and banks is aligned. We relax some of the assumptions to show a broad spectrum of shocks that can adversely affect credit market developments. Specifically, we allow banks to format autonomous decisions regarding lending policy. Furthermore, banks' views on productivity shock

[9] Detailed derivations are presented in Appendix 6.

distribution may differ from those assumed by the firms. Both extensions provide additional theoretical justification for the existence of liquidity holdings in light of credit market imperfections.

Consider a three-period model with banking and production sectors, risk-neutral agents, and a constant risk-free rate of return ρ. Agents are allowed to form decisions in periods zero and one, while in period two, the total output is distributed according to their prior decisions. Both firms and banks optimise the discounted stream of dividends.

4.2.2.1 Firms' optimisation problem

A firm chooses the optimal investment in production (I_t) in periods zero and one according to its production function:

$$Y_t = F(I_{t-1}) + \varepsilon_t \tag{4.1}$$

where Y_t is the output in period *t*, and $F(I_{t-1})$ is twice continuously differentiable strictly increasing and strictly concave function, with $F(0) = 0$, $F'(0) = \infty$, and $F'(z) \to 0$ as $z \to \infty$. ε_t is independently and identically uniformly distributed shock in production, $\varepsilon_t \sim U\left[\underline{\varepsilon}, \overline{\varepsilon}\right]$, where $\underline{\varepsilon}$ and $\overline{\varepsilon}$ represent the lowest and highest values of the production shock assumed by the firms. A good approximation for the upper and lower bound could be determined by the historically observed occurrences.

In period zero, the firm allocates the initial endowment X_0^F between the shareholders' dividends, investment in production and investment in liquidity (e.g., highly liquid assets) L_0. The latter is costly, as the return on liquid assets is lower than the risk-free rate of return ($r_L < \rho$).[10] In period one, the firm observes the production shock ε_1 and chooses the investment in production, the amount of borrowing B_1 to finance the investment decision, and the dividends for shareholders D_1^F. The firm incurs a proportional cost of borrowing[11] ($\theta \in [0,1]$) and the return on borrowed funds, defined by the bank return function $G(B_1)$. Following Kim et al. (1998), we adopt a necessary condition for a nonzero investment at time zero:

$$F(I_0^*) + \underline{\varepsilon} < I_1^* \tag{4.2}$$

[10] Assuming $r_L < \rho$ restricts our solution set. Thus, liquidity is held only in case of its offsetting benefit since its net present value is negative.

[11] We follow Kim et al. (1998) in the assumption of proportional costs on borrowed funds. The assumption is convenient in terms of derivations and does not affect our conclusions.

where I_t^* denotes the optimal investment in production under the assumption of costless external financing. If the condition were not satisfied, the banking sector would not be necessary as the optimal investment in period zero would provide firms with the necessary funds for optimal investment in period one, even in the case of the worst possible production shock.

In period two, the firm pays off the banks and then issues a liquidating dividend D_2^F to shareholders. Given that the produced output is random, the return to banks and shareholders is uncertain. However, due to the limited liability of firms, banks require an endogenously determined return to issued loans, determined by the bank return function $G(B_1)$ to compensate for the risk associated with production shocks.

The firm's objective function is a sum of the discounted expected value of the dividend stream to shareholders. Dividends paid in period one D_1^F are predetermined by the amount of production in period zero $F(I_0)$, liquidity acquired in period zero L_0, return on liquidity holdings r_L, and the proportional cost of borrowing θ. The solution of the optimisation problem is solved recursively by dynamic programming. The solution to the problem in period two is trivial, as the firm only distributes dividends D_2^F to shareholders. In period one, the maximisation problem is the following:

$$
\begin{aligned}
&\max_{\{B_1, I_1\}} \left\langle D_1^F + (1+\rho)^{-1} E_1^F \left[D_2^F \right] \right\rangle \\
&s.t. \\
&D_1^F \geq 0 \\
&I_1 \geq 0 \\
&B_1 \geq 0 \\
&D_1^F = F(I_0) + \varepsilon_1 + L_0(1+r_L) + B_1(1-\theta) - I_1 \\
&E_1^F \left[D_2^F \right] = \int_{\underline{\varepsilon_2}}^{\overline{\varepsilon_2}} \max\left[F(I_1) + \varepsilon_2 - G(B_1); 0 \right] g(\varepsilon_2) d\varepsilon_2
\end{aligned}
\tag{4.3}
$$

where $g(.)$ denotes the probability density function of ε_t, $E_1^F[.]$ denotes the firm's expectations about the developments in period two based on the information available in period one.[12] The optimisation problem takes into account the cost of investment, hinting at the relevance of the financial market frictions for business investment. We can observe that the problem at hand exhibits a significant amount of complexity, stemming from the fact that return to loans itself is a function and is subjected to the distinct bank optimisation process. It is worth noting that the amount of interest and other costs associated with bank

[12] We distinguish between $E_t^F[.]$ and $E_t^B[.]$ because the distributions of the production shocks differ from the firm's and bank's points of view.

lending decreases the expected dividends of shareholders. Therefore, the equilibrium lending rate and amount of loans are determined in the credit market that we want to study.

Given the solution to (4.3) and the bank's optimisation problem in period one (4.5), which is further elaborated in subsection 4.2.2.2, the firm's optimisation problem in period zero is the following:

$$
\begin{aligned}
&\max_{\{L_0, I_0\}} \left\langle D_0^F + (1+\rho)^{-1} E_0^F \left[V_1 \right] \right\rangle \\
&s.t. \\
&D_0^F \geq 0 \\
&I_0 \geq 0 \\
&L_0 \geq 0 \\
&D_0^F = X_0^F - L_0 - I_0 \\
&V_1 = \max_{\{B_1, I_1\}} \left\langle D_1^F + (1+\rho)^{-1} E_1^F \left[D_2^F \right] \right\rangle
\end{aligned}
\tag{4.4}
$$

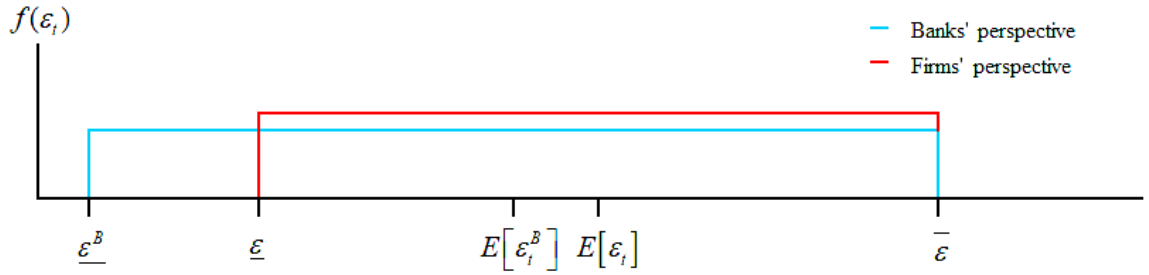
where X_0^F is the initial endowment of the firm at the beginning of period zero, and D_0^F are the dividends paid by the firm in period zero. V_1 represents the solution to the firm's optimisation problem in period one.

4.2.2.2 Banks' optimisation problem

Banks choose the optimal investment in liquidity in periods zero and one and the optimal level of loans in period one if the production shock in period one is low enough that the demand for loans exists. Banks' choices are subjected to the expected return to loans function denoted by $G(B_1)$, which is twice continuously differentiable, strictly increasing, and strictly concave function, with $G(0) = 0$, $G'(0) = \infty$, and $G'(z) \to 0$ as $z \to \infty$. Furthermore, banks observe a different probability density function of production shocks such that $\varepsilon_t^B \sim U\left[\underline{\varepsilon}^B, \bar{\varepsilon}\right]$, where we assume that the lower bound of production shock distribution from the perspective of a bank ($\underline{\varepsilon}^B$) may differ from the one assumed by firms ($\underline{\varepsilon}$). Thus, ε_t^B may exhibit a wider probability density function in comparison to ε_t.

Therefore, from the banks' point of view, the probability of extreme adverse events is higher, and the minimum values attained by the shock can be lower than $\underline{\varepsilon}$. The difference in the notion of the probability density function shows the uncertainty related to the agent problem (Stiglitz, 1985). Firms' and banks' perceptions of the probability density function of production shocks are shown graphically in Figure 4.1.

Figure 4.1: Firms' and banks' perceptions of the probability density function of production shocks



Source: Own work.

In period zero, the bank allocates the initial endowment of funds denoted by X_0^B to liquidity reserves L_0^B and dividends to shareholders D_0^B. The bank generates an uncertain return on the liquidity investment (r_B), which may differ from the return on firms' liquidity investment. In period zero, banks can invest in firms if the production shock in period one is low enough to generate the loan demand. Another option is to reinvest in the liquidity reserves to obtain an uncertain return (r_B) or to simply allocate the entire asset value to dividends. The return on firms' loans is uncertain as it depends on the production shock. Furthermore, the distribution of production shocks, acknowledged by the bank, differs from that of non-financial firms.

The bank's objective function is a sum of the discounted expected value of the dividend stream (D_0^B, D_1^B, and D_2^B) to shareholders. The optimisation problem is constrained by the bank's liquidity holdings L_0^B, return on liquidity holdings r_B, and the proportional return on lent funds θ. The solution of the optimisation problem is again solved recursively by dynamic programming. The solution to the problem in period two is trivial as the bank only receives the return on loans to firms and returns on liquid assets and distributes them to shareholders.[13] The maximisation problem in period one is the following:

[13] If $r_B < \rho$ and the production shock in period one is high enough to allow a formation of loan demand, it may happen that the bank pays the entire value in dividends already in period one.

$$
\begin{aligned}
&\max_{\{B_1, L_1^B\}} \left\langle D_1^B + (1+\rho)^{-1} E_1^B \left[D_2^B \right] \right\rangle \\
&s.t. \\
&D_1^B \geq 0 \\
&L_1^B \geq 0 \\
&B_1 \geq 0 \\
&D_1^B = L_0^B (1+r_B) - B_1 (1-\theta) - L_1^B \\
&E_1^B \left[D_2^B \right] = \int_{\underline{\varepsilon_2^B}}^{\overline{\varepsilon_2}} \min \left[F(I_1) + \varepsilon_2; G(B_1) \right] g(\varepsilon_2) d\varepsilon_2
\end{aligned}
\tag{4.5}
$$

where B_1 denotes the funds allocated for firms' borrowing and constitute the loan supply, L_1^B denotes the liquid assets that the bank transfers in the next period at the bank's return on liquidity investment r_B, and $E_1^B[.]$ denotes the bank's expectations about the developments in period two based on the information available in period one.

In period zero, the bank chooses the allocation of funds in the liquidity to form a base for possible investment in period one. We can see the importance of the return on bank liquidity assets exceeding the risk-free return ($r_B \geq \rho$). This assumption guarantees the existence of loan supply in period one. The banks' maximisation problem in period zero has the following form:

$$
\begin{aligned}
&\max_{\{L_0^B\}} \left\langle D_0^B + (1+\rho)^{-1} E_0^B \left[V_1^B \right] \right\rangle \\
&s.t. \\
&D_0^B \geq 0 \\
&L_0^B \geq 0 \\
&D_0^B = X_0^B - L_0^B \\
&V_1^B = \max_{\{B_1, L_1^B\}} \left\langle D_1^B + (1+\rho)^{-1} E_1^B \left[D_2^B \right] \right\rangle
\end{aligned}
\tag{4.6}
$$

where X_0^B refers to the initial endowment of the banks and is assumed to be high enough so that $D_0^B = 0$ ensures the existence of sufficient bank funds in period one, and V_1^B denotes the solution to the bank's optimisation problem in period one.

4.2.3 Analysis of the model

The optimal investment in production in period one can be divided into three outcomes of the production shock in period one:

– if the production shock (ε_1) exceeds the high production shock (ε_1^*), i.e., $\varepsilon_1 > \varepsilon_1^*$, the firm does not demand external financing and invests the optimal amount (I_1^*);
– if the production shock (ε_1) exceeds the threshold level ($\hat{\varepsilon}_1$) but is below the high production shock (ε_1^*), i.e., $\hat{\varepsilon}_1 < \varepsilon_1 < \varepsilon_1^*$, the firm does not demand external financing and invests a suboptimal amount (I_1);
– if the production shock (ε_1) is lower than the threshold level ($\hat{\varepsilon}_1$), i.e., $\varepsilon_1 < \hat{\varepsilon}_1$, the firm demands external financing and invests the suboptimal amount (I_1).

The optimal investment amount I_1^* is consistent with the assumption of unlimited costless financing. From the solution of the firms' optimisation problem, we can deduce that the optimal level of investment depends on the risk-free rate of return and the probability of high production shock in period two from the point of view of a firm $P^F(\varepsilon_2 > \varepsilon_2^*)$:

$$F'(I_1^*) = \frac{1+\rho}{\mathrm{P}^F(\varepsilon_2 > \varepsilon_2^*)} \tag{4.7}$$

The production shock for which the firms' dividends are positive in the second period is denoted by ε_2^*.[14]

The opposite scenario, with the production shock on the lower spectrum, is especially interesting for our analysis as, in this scenario, the credit market is formed. On the credit market, firms demand the missing funds for investment, while banks supply the funds in accordance with their profit function. Technically, the optimal investment is obtained by joint optimisation of the firms' and banks' optimisation problems. On the firms' side, we can derive that the level of investment is suboptimal and is defined as a function of the proportional cost of borrowing (θ) and the banks' marginal return on the borrowed funds $G'(B_1)$:

$$F'(I_1) = \frac{G'(B_1)}{1-\theta} \tag{4.8}$$

The banks' optimisation problem reduces to the optimal lending to firms, defined by:

$$G'(B_1) = \frac{(1-\theta)(1+r_B)}{\mathrm{P}^B(\varepsilon_2 > \varepsilon_2^*)} \tag{4.9}$$

Where $P^B(\varepsilon_2 > \varepsilon_2^*)$ denotes the bank's probability of observing the productivity shock larger than ε_2^*. From equation (4.9), we can infer that the amount of borrowing depends

[14] It is worth noting that the higher the value of the derivative of the production function, the lower the amount of investment in production. This conclusion follows from the properties of the production function.

positively on the banks' belief about the probability of a high production shock in period two. Furthermore, the amount of borrowing depends negatively on the return on bank deposits (r_B) and positively on the proportional cost of borrowing (θ). Entering the expression (4.9) in (4.8) yields the equilibrium amount of the firm's investment after the low realisation of the production shock in the first period:

$$F'(I_1) = \frac{1 + r_B}{\mathrm{P}^B(\varepsilon_2 > \varepsilon_2^*)} \tag{4.10}$$

The level of investment attained in the low production shock scenario I_1 is lower than the optimal investment amount I_1^*, which would be attained in perfect capital markets. According to our theoretical model, the reason lies in the banks' opportunity cost of the risk-free return and banks' perception of the riskiness of the investment. Evidently, for $\rho = r_B$ and $\mathrm{P}^B(\varepsilon_2 > \varepsilon_2^*) = \mathrm{P}^F(\varepsilon_2 > \varepsilon_2^*)$ the amount of investment is optimal for all realisations of the production shock.

Costly investment in production under the necessity of borrowing encourages firms to form liquidity reserves in period zero L_0 to fund investment in production in period one I_1. For convenience, we assume that the initial endowment of firms in period zero is high enough to allow any optimal choice of I_0 and L_0. We can solve the problem by assuming $L_0 = 0$ and following up with assumption that $L_0 > 0$ to obtain the whole spectrum of solutions. We obtain the solution that:

$$\begin{aligned} (1 + r_L) \le F'(I_0) &= \frac{1 + \rho}{\mathrm{P}^F(\varepsilon_1 > \varepsilon_1^*)} - \frac{1}{(1 + \rho)\mathrm{P}^F(\varepsilon_1 > \varepsilon_1^*)} Z \\ Z &= \int_{\varepsilon_1}^{\varepsilon_1^*} F'\left[F(I_0) + \varepsilon_1 + L_0(1 + r_L)\right] g(\varepsilon_1) d\varepsilon_1 \end{aligned} \tag{4.11}$$

Hence, the upper level of investment in production is defined by $F'(\overline{I_0}) = (1 + r_L)$. The upper limit is thus set by the rate of return on liquid assets and is in line with the results obtained by Kim et al. (1998), since the solution does not depend on the inclusion of the banks.

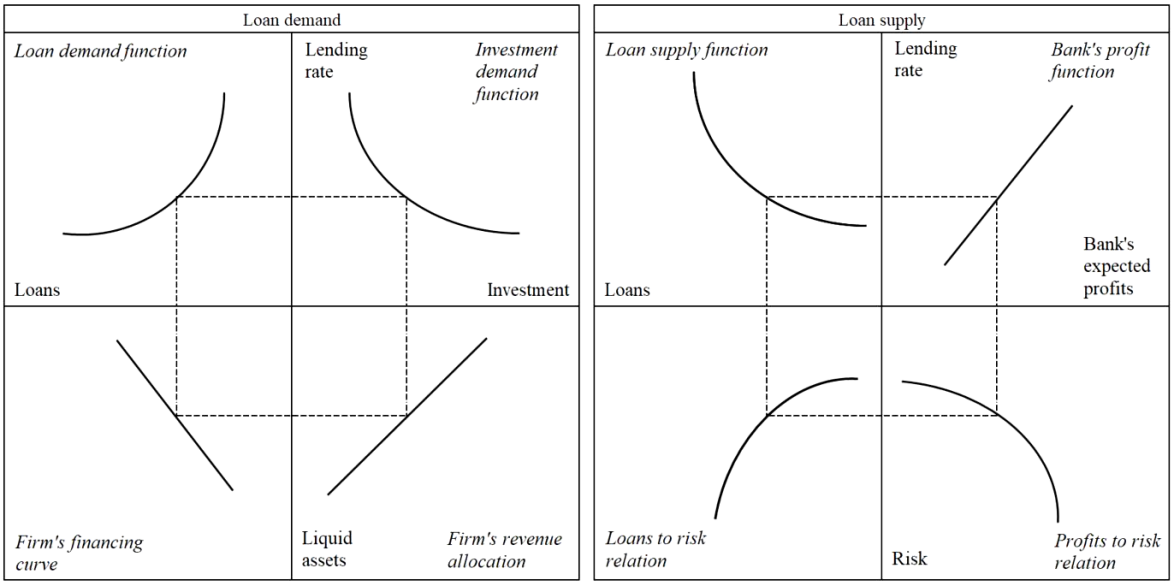
The general solution in case of $L_0 = 0$ shows that the firm will overinvest in production $F'(I_0) < F'(I_0^*)$ if it has no option to invest in liquidity. This proves the optimality of liquidity investment that persists even under the negative net present value assumption.

4.2.4 Graphical representation

In this section, we use our theoretical model to showcase the graphical representation (Figure 4.2) used in the identification of structural shocks in the empirical part of the chapter in the next section. Although our theoretical model is limited to only three periods, we can think of it in the continuous time setting with multiple agents. The loan demand (left) and loan supply functions (right), which are constructed separately, form the equilibrium loan level and lending rate at the intersection of the credit market.

The investment demand function in our model is represented by the optimal investment, which is defined by the production function and the lending rate. Thus, in the graphical representation, changes in the production function would induce a shift in the investment demand function or the so-called investment demand shock in the empirical analysis. In an equilibrium condition, such a shock would shift the loan demand function accordingly. In our model, the firms' financing curve is represented by investment financing, where higher investment in production drains out the liquidity investment. A sudden increase in the risk of a low production shock would increase firms' required liquidity investment at the expense of investment in production. Changes in the perceived distribution of the production shock would increase the firms' financing curve together with the loan demand function. In the empirical analysis, we refer to this shock as 'the liquidity demand shock'.

Figure 4.2: Graphical representation of the theoretical model



Source: Own work.

On the loan supply side, banks' profit function displays a relation between the amount of outstanding loans and the expected profits. The function is strictly increasing and concave, accounting for the increasing riskiness of debt issues. An increase in the bank profit function increases the loan supply function as the marginal return on issued loans suddenly

increases. A change in the banks' perspective on the riskiness of an investment is denoted as the credit risk shock. It is worth noting that in this context, the increased risk is an exogenous, unexpected change in the banks' view of the production shock probability density function. In the graphical representation, such shock would shift the loans to risk relation and the loan supply function accordingly.

4.3 Empirical framework

With their dynamic setting, vector autoregressive models (VARs) have proven to be an efficient workhorse approach to empirical macroeconomics. Reduced-form VARs have an advantage in describing interactions among the economic variables without possibly imposing incredible restrictions on the parameters, as argued by Sims (1972). However, the reduced form VARs may suffer from low degrees of freedom as a consequence of a large number of estimated parameters, which increases linearly with the number of lags and geometrically with the number of endogenous variables. Furthermore, with the avoidance of any restrictions, the reduced-form VAR models are simply a representation of the data and are not well suited to conduct meaningful policy analysis.

We address the problem of over-parametrisation of the model through the lens of the Bayesian approach to specification and estimation of VARs, well described by Ciccarelli and Rebucci (2003). The identification of the model is addressed by the sign restriction approach, well described by Uhlig (2005), Arias, Rubio-Ramirez, and Waggoner (2014), where an explicit restriction on the shape of the impulse response functions identifies the structural shocks. It is noteworthy that the sign restriction identification is inherently related to the Bayesian estimation as the draws from the prior distribution can be performed jointly for the purpose of a sign restriction identification and the VAR parameters, as discussed by Moon and Schorfheide (2012).

4.3.1 Bayesian VAR

The Bayesian approach in the estimation of the VAR model provides a formal way of using exogenous information about the parameter space to reduce the variance of unrestricted parameter estimates. The frequentist approach is based on nonstochastic parameter space Φ for which it is assumed to govern the data-generating process from which the observed sample can be obtained. The Bayesian approach, in contrast, is fundamentally different. The parameter space Φ is treated as stochastic, while the dataset is nonstochastic. The belief about the parameters, expressed in the form of a prior probability distribution of parameters, is a crucial assumption for estimating the model. With the estimation of the model, we form a posterior distribution of parameters based on the prior distribution and the observed data, which affect the posterior through the likelihood function of the model (Kilian & Lütkepohl, 2017).

The Bayesian estimation of the VAR model can be formally written in the following way:

$$Y_t = X_t\beta + \varepsilon_t \tag{4.12}$$

where for the periods $t = 1,...,T$ it holds that $X_t = (I_n \otimes W_{t-1})$ is an *n x nk* matrix, $W_{t-1} = (Y'_{t-1},...,Y'_{t-p}, z'_t)'$ is a *k x 1* vector, and $\beta = vec(B_1, B_2,...., B_p, D)$ is an *nk x 1* vector. The parameters that are subject to estimation are β and Σ.

The likelihood function of the data conditional of the parameters can be expressed as follows:

$$L(Y|\beta,\Sigma) \propto |\Sigma|^{-T/2} \exp\left\{-\frac{1}{2}\sum_t (Y_t - X_t\beta)'\Sigma^{-1}(Y_t - X_t\beta)\right\} \tag{4.13}$$

where $\propto$ denotes proportionality. The Bayes rule allows us to obtain the posterior distribution of parameters by combining the likelihood function of the data with the joint probability distribution of the parameters:

$$p(\beta,\Sigma|Y) = \frac{p(\beta,\Sigma)L(Y|\beta,\Sigma)}{p(Y)} \propto p(\beta,\Sigma)L(Y|\beta,\Sigma) \tag{4.14}$$

By the definition of conditional probability, the joint probability distribution function of the data and the parameters, $p(\beta,\Sigma,Y)$, can be written as follows:

$$\begin{aligned} p(\beta,\Sigma,Y) &= L(Y|\beta,\Sigma)\,p(\beta,\Sigma) \\ &= p(\beta,\Sigma|Y)\,p(Y) \end{aligned} \tag{4.15}$$

From the conditional probability $p(\beta,\Sigma|Y)$, the marginal posterior distributions, $p(\Sigma|Y)$ and $p(\beta|Y)$, can be obtained by integrating out β and Σ from $p(\beta,\Sigma|Y)$, respectively. The medium values and dispersion of $p(\Sigma|Y)$ and $p(\beta|Y)$ can be used to obtain the estimates of the parameters of interest and measures of precision comparable to those obtained using a classical estimation approach.

The posterior distribution is often not available in the closed form. However, it can be approximated by the numerical integration based on Monte Carlo simulations. In this analysis, we use the Gibbs sampler, which is a recursive Monte Carlo method based only on the assumption about the full conditional posterior distribution of the estimated parameters as described, for example, in Ciccarelli and Rebucci (2003).

As already noted, the choice of the prior distribution is an important starting point for the Bayesian estimate of the parameters. In this analysis, we accept the Normal-Wishart prior distribution of parameters, which allows the variance-covariance matrix to deviate from the

fixed diagonal matrix, as assumed in the case of Minnesota prior (Litterman, 1986). The Normal-Wishart prior implies the following assumptions about the parameter distributions:

$$\begin{aligned} p(\beta|\Sigma) &= N(\bar{\beta}, \Sigma \otimes \bar{\Omega}) \\ p(\Sigma) &= iW(\bar{\Sigma}, \alpha) \end{aligned} \tag{4.16}$$

Specifically, the unconditional prior distribution of β will be normal with prior mean and variance, $E(\beta) = \bar{\beta}$ and $V(\beta) = (\alpha - n - 1)^{-1}\bar{\Sigma} \otimes \bar{\Omega}$, respectively, where α denotes the degrees of freedom of the inverse-Wishart and satisfies $\alpha > n + 1$ (n denotes the sample size). The setting ensures that both the prior variances of β and the posterior variances of the forecasts at $T+h$ are defined. It is worth noting that the Kronecker structure of the variance of $\bar{\beta}$ is necessary for obtaining an analytically accessible posterior distribution without the assumption of Σ being known.

Assuming the Normal-Wishart prior brings us the following expression for the posterior distribution as derived in Kadyiala and Karlsson (1997) and Karlsson (2013) and described in Ciccarelli and Rebucci (2003):

$$\begin{aligned} p(\beta|\Sigma, Y) &= N(\tilde{\beta}, \Sigma \otimes \tilde{\Omega}) \\ p(\Sigma|Y) &= iW(\tilde{\Sigma}, T + \alpha) \end{aligned} \tag{4.17}$$

where

$$\tilde{\Omega} = (\bar{\Omega}^{-1} + X'X)^{-1}$$
$$\tilde{B} = \tilde{\Omega}(\bar{\Omega}^{-1}\bar{B} + X'X\hat{B}_{ols})$$
$$\tilde{\Sigma} = \hat{B}'_{ols}X'X\hat{B}_{ols} + \bar{B}'\bar{\Omega}^{-1}\bar{B} + \bar{\Sigma} + (Y - X\hat{B}_{ols})'(Y - X\hat{B}_{ols}) - \tilde{B}'(\bar{\Omega}^{-1} + X'X)\tilde{B}$$

In the case of Normal-Wishart prior, it is necessary to assume that values of $\bar{\beta}$, $\bar{\Omega}$, and $\bar{\Sigma}$ are known. They can be obtained by the dummy observations (Y_d and X_d) of size T_d, such that:

$$\bar{\beta} = vec(\bar{B}) = vec((X'_d X_d)^{-1} X'_d Y_d) \tag{4.18}$$

$$\bar{\Omega} = (X'_d X_d)^{-1} \tag{4.19}$$

$$\bar{\Sigma} = (Y_d - X_d\bar{B})'(Y_d - X_d\bar{B}) \tag{4.20}$$

$$\alpha = T_d - k$$

Such an estimation method was introduced by Theil (1963) in the context of a classical estimator for stochastically restricted coefficients. In this way of estimation, the posterior

estimator efficiently combines the data and the prior information via direct sampling in the spirit of Theil and Goldberger (1961).

4.3.2 Data

We estimated the BVAR model to test our theoretical approach's relevance to Slovenia's small open economy. The set of variables in the BVAR model allows us to recover four fundamental structural shocks of the business credit market. The model is estimated by including four endogenous variables: lending rate for non-financial firms, loans to non-financial firms, business investment, and the index of financial stress (country-level index of financial stress (CLIFS)) for Slovenia. Additionally, we controlled for the monetary policy actions by including the shadow short-term interest rate (Wu & Xia, 2017, 2020) and the general business cycle by including the euro area GDP. In this section, we describe the main reasons for the variable selection, while details on the definition, transformation, and sources of the data, as well as the summary statistics, are reported in Table A55 in Appendix 7. Additionally, we provide the results of the tests for the stationarity of the transformed time series utilised in the analysis (Tables A56–A59). The dataset of the quarterly frequency spans from 1999Q1 to 2022Q3.

The firm-specific lending rates for non-financial firms allow us to understand one of the critical components of the business credit market: the price of the loan. Including the composite business lending rate along with the short-term interest rate is meaningful from the perspective of pass-through of the monetary policy actions to the actual lending rate.

With the inclusion of business loans, we include the quantity variable of the credit market analysis. We transform the series to real business loans to exclude the effects of high inflation rates throughout the transition period. Consistently with the lending rate, we included short-term and long-term business loans, although the business investment usually relates to long-term business loans if financed through banking funds. There are at least two reasons for such an approach: first, the non-financial sector in Slovenia has a high stock of deposits, which allows the firms to finance their investment if bank lending cannot provide short-term liquidity. Second, it allows us to shed some light on the effects of the uncertainty and liquidity demand shocks, as they are both short-term phenomena.

Business investment is calculated from the National Accounts and National Sectoral Accounts data. We define business investment as part of the gross fixed capital formation, unexplained by government investment and investment in residential buildings. The final series of the business investment is further deflated by the gross fixed capital formation deflator. Real business investment represents approximately 11% of the GDP in Slovenia (IMAD, 2023). Furthermore, due to the high volatility of business investment, we aim to explain the effects of structural shocks on investment dynamics to better understand the historical drivers of business investment decisions.

As a last endogenous variable, we include the indicator of financial stress in Slovenia. The indicator was developed by Duprey, Klaus, and Peltonen (2017) to transparently date systemic financial stress events. The model is based on the Markov-switching model to define the high financial stress regimes, which are associated with a substantial negative impact on the real economy. The indicator of financial stress is based on six market-based measures of financial stress that capture three main segments of the financial market: equity markets, bond markets, and foreign exchange markets. In addition, we included the financial stress indicator in the model to account for the increasing risk impacts on the credit market equilibrium.

4.3.3 Sign restriction

Identification of the VAR model allows us to present the reduced form innovations in a structural way and allows one to derive the economically meaningful shocks as suggested by the work of Sims (1980). In the sign restrictions approach to identify structural VAR models, structural shocks are identified by an explicit restriction on the shape of the impulse response functions. The approach was pioneered by Faust (1998), Canova and De Nicolo (2002), and Uhlig (2005) but has been popularised and extended only recently by Arias, Rubio-Ramirez, and Waggoner (2014), Rubio-Ramirez, Waggoner, and Zha (2010), Ahmadi and Uhlig (2015), Antolín-Díaz and Rubio-Ramírez (2018), and many other empirical applications.

We will further explain the sign restriction identification in the framework of the Householder transformation in the Bayesian context, popularised by Rubio-Ramirez, Waggoner, and Zha (2010). The space of $K \times K$ orthogonal matrices can be recovered by drawing columns of a random matrix W from a normal distribution $N(0, I_K)$, followed by applying the QR decomposition to each draw of matrix W. Rubio-Ramirez, Waggoner, and Zha (2010) have shown that matrices Q from the QR decomposition of W amount to random draws of Q from the uniform distribution over the space of orthogonal matrices under the condition that diagonal elements of R are positive. Thus, the algorithm enables obtaining a substantial amount of identification matrices $B_0 = PQ$, where P is a lower triangular Cholesky decomposition of reduced form residuals (Kilian & Lütkepohl, 2017). Note that Fry and Pagan (2011) explained the equivalence of this approach to the use of Givens rotation matrices. However, this approach is computationally efficient.

In the empirical literature, sign restrictions are commonly applied in the context of Bayesian inference, although the identification process remains valid in the frequentist context. In the Bayesian context, it is possible to construct a posterior distribution of the structural impulse responses by drawing from a posterior distribution of reduced form parameters and applying a QR algorithm to each draw. We continue by keeping the valid draws and discarding the others (Kilian & Lütkepohl, 2017). The distribution of the structural impulse response functions reflects the uncertainty related to estimation and

identification as opposed to the conventional VAR models, where the former is usually neglected in the sign restriction context.

The identification process, well-described by Kilian and Lütkepohl (2017), can be formalised as follows:

- Make a random draw of reduced form parameters ($\tilde{B}^r$, $\tilde{\Sigma}^r$) from the posterior distribution.
- Compute the lower-triangular Cholesky decomposition $P^r = chol(\tilde{\Sigma}^r)$.
- Make *N* random draws of rotation matrices *Q* and compute implied impulse responses from the set of drawn parameters $\theta^r = (\tilde{B}^r, P^r, Q)$.
- If θ^r satisfies the restrictions, store θ^r, otherwise discard it.
- Repeat the procedure *M* times.

If *N* and *M* are sufficiently large, the posterior distribution of the impulse responses is well approximated. However, a sufficiently large number of draws is inversely related to the tightness of identifying restrictions.

4.3.4 Identification of structural shocks

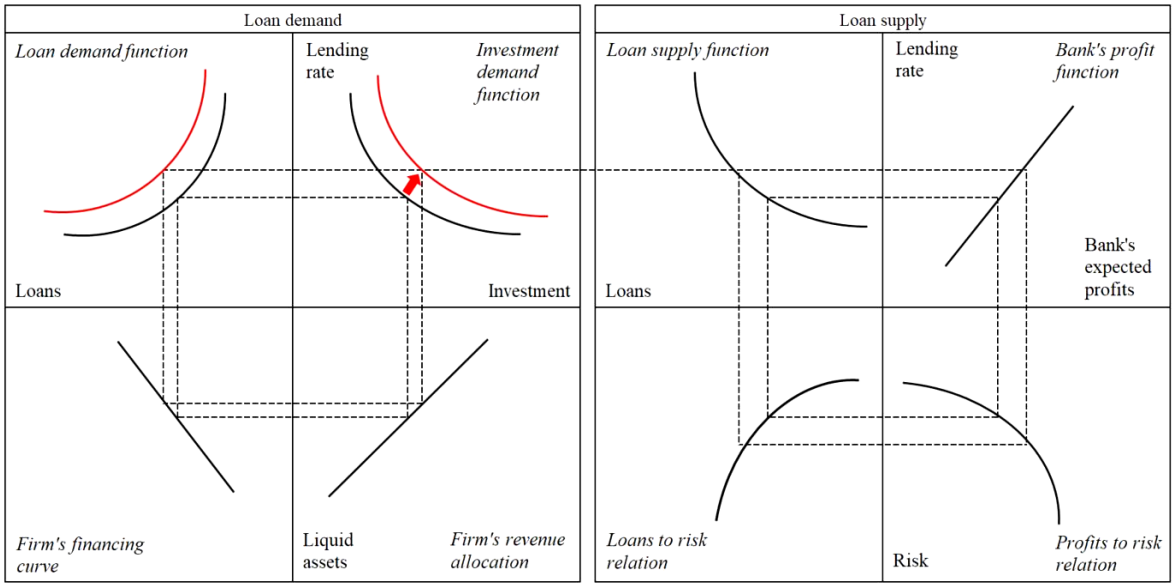
In order to identify the underlying shocks that affect the credit market equilibrium, we rely on curve changes in the theoretical model, presented in the previous section. On the surface, it might seem sufficient to address the credit market by the direct impact of the credit supply and demand shocks, usually defined solely by the changes in the credit market equilibrium. However, our theoretical model goes deeper in order to investigate the potential underlying sources that may have the same impact on the credit market equilibrium in terms of the sign of the response; the responses may differ in terms of significance, relevance, and magnitude. The identification strategy assumes four distinct shocks that may affect the credit market.

We hypothesise that the changes in business credit demand stem from the *investment demand shocks* and the *liquidity demand shocks*. In contrast, credit supply is affected by *credit risk shocks* and the *banks' profit function shocks*. The aforementioned shocks are described in this section, along with the graphical representation of shifts in the relevant curves to motivate the sign restrictions, emphasising our theoretical model of the credit market. The sign restriction identification of structural shocks is consistent with the contribution of Eickmeier and Ng (2015), Gambetti and Musso (2017), and Moccero et al. (2014).

Investment demand shock is identified as a shift in the investment demand function (Figure 4.3). A sudden shift in the investment demand may be caused by disequilibrium in the production factors due to an increase in the marginal productivity of capital caused by the

technology shock, as in Greenwood, Hercowitz, and Huffman (1988), or a disproportionate increase in wages relative to the marginal productivity of labour, set forth by Hall (1997). Justiniano, Primiceri, and Tambalotti (2011) also studied the importance of the marginal efficiency of investment on the business cycles in the light of different drivers of investment efficiency. In this chapter, we abstain from drawing a line between the reasons behind a shift in investment demand, as our primary focus is on the credit market. Investment demand shock contemporaneously increases the business investment, together with the lending rate and the outstanding loans. As the amount of outstanding business loans increases, it also positively affects the index of financial stress in accordance with our theoretical model.

Figure 4.3: Graphical representation of the investment demand shock



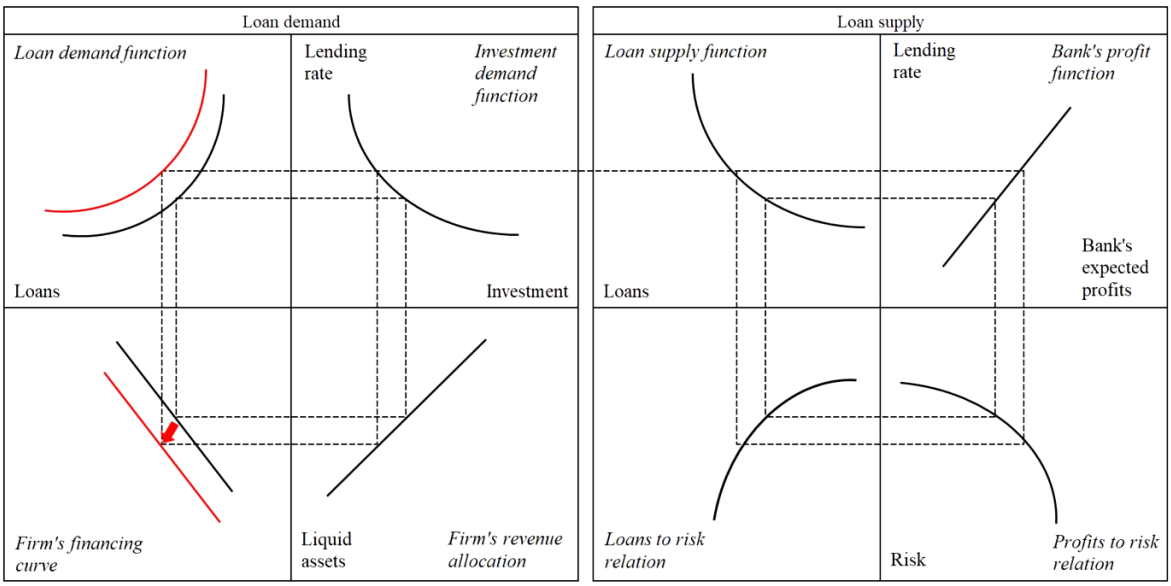
Source: Own work.

Liquidity demand shock is another reason behind the unexpected rise in loan demand (Figure 4.4). During the strong final product demand period, firms are prone to hold more inventories to limit the risk of diminished production. A high inventory environment increases the need for stable financing and strong liquidity, even at the expense of investment. This phenomenon was noted by Maksimović and Yook (2022), who analysed the period of the Great Recession to find that firms with strong demand need more liquidity for their suppliers than firms with lower demand for the final goods.

Liquidity demand shock is also consistent with the stream of the theory that focuses on the advantages of liquidity provisions in case of financial distress, when borrowing may become very costly. A higher level of liquidity positively affects the firm during the downturn, as discussed in Almeida et al. (2011). In light of our theoretical setting, liquidity is necessary to protect a firm's future dividends in the case of unfavourable economic conditions. Liquidity demand shock increases the outstanding amount of loans along with

the lending rate. In contrast, business investment is dampened as the firm decides in favour of higher liquidity holdings. Financial risk increases along with the outstanding amount of loans as the banking sector becomes more vulnerable to external shocks that have an impact on credit risk.

Figure 4.4: Graphical representation of the liquidity demand shock

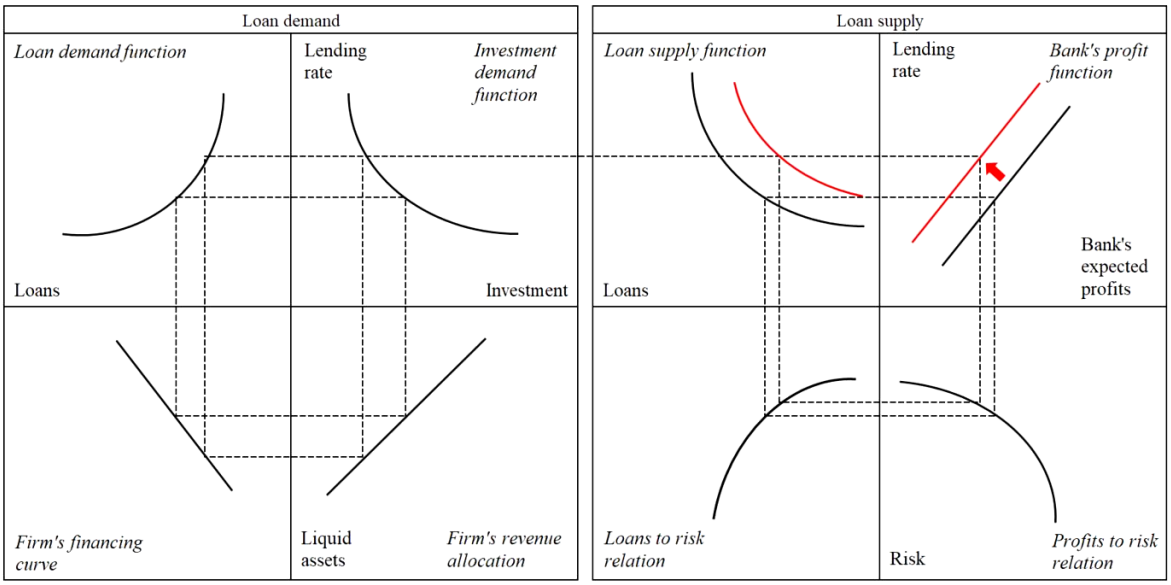


Source: Own work.

On the loan supply side of the credit market, we identify two distinct shocks that decrease the loan supply function. Gambetti and Musso (2017) stated that: "*Intuitively, a loan supply shock can be associated with various events, such as unexpected changes in bank capital available for loans (e.g., due to a change in regulatory capital ratio requirements), changes in bank funding (for instance following bank runs or the introduction of credible deposit insurance schemes or changes in the ceiling of the latter), changes in the risk perception of potential borrowers by bank management (for example following changes in key bank managerial positions or innovations in bank monitoring technology) or changes in the degree of competition in the banking sector*." In our approach, we differentiate between the loan supply shock that occurs as a consequence of a shift in the function of risk perception and a change in the profit function that can be affected by the degree of competition, changes in bank capital, or funding. Therefore, differentiation between these two shocks is vital, as the risk channel is not in the control of the banks and may be the main factor behind the financial accelerator effect.

Bank profit function shock simultaneously increases the lending rate on the business loans as well as decreases the outstanding amount of business loans (Figure 4.5). As the investment becomes more costly, firms reduce their investment rate. Furthermore, with a deflated balance sheet, the bank faces lower risk due to lower exposure to the private sector.

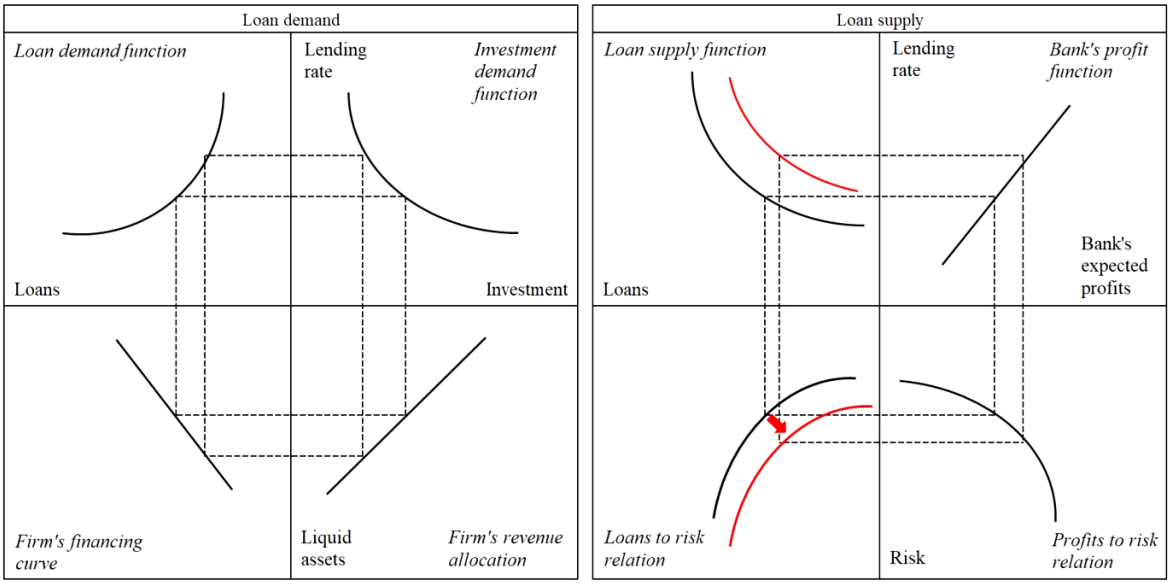
Figure 4.5: Graphical representation of the bank profit function shock



Source: Own work.

Credit risk shock is related to a change in the risk perception of borrowers (Figure 4.6). Due to higher risk levels, the bank is inclined to hold higher reserves. Consequently, the loan supply function and investment decrease. The impact on the lending rate is ambiguous as the risk shock can also decrease the investment demand function. Therefore, we do not restrict the contemporaneous impact on the lending rate.

Figure 4.6: Graphical representation of the credit risk shock



Source: Own work.

Our identification, summarised in Table 4.1, thus builds on the theoretical representation of the credit market.

Table 4.1: Sign restrictions

Shock	Lending Rate	Business Loans	Business Investment	CLIFS
Investment demand shock	+	+	+	+
Liquidity demand shock	+	+	-	+
Banks' profit function shock	+	-	-	-
Credit risk shock	+	-	-	+

Note: All shocks are normalised to imply an increase in the lending rate. The sign restrictions are imposed only on impact. CLIFS refers to the country-level index of financial stress.

Source: Own work.

4.4 Results

In this section, we present the main outcomes of the structural BVAR model related to the identified structural shocks. We present the impulse response functions, forecast error variance decompositions, and historical decomposition in order to recover the average responses of variables to specific shocks as well as the historical relevance of identified shocks.[15]

4.4.1 Impulse response functions

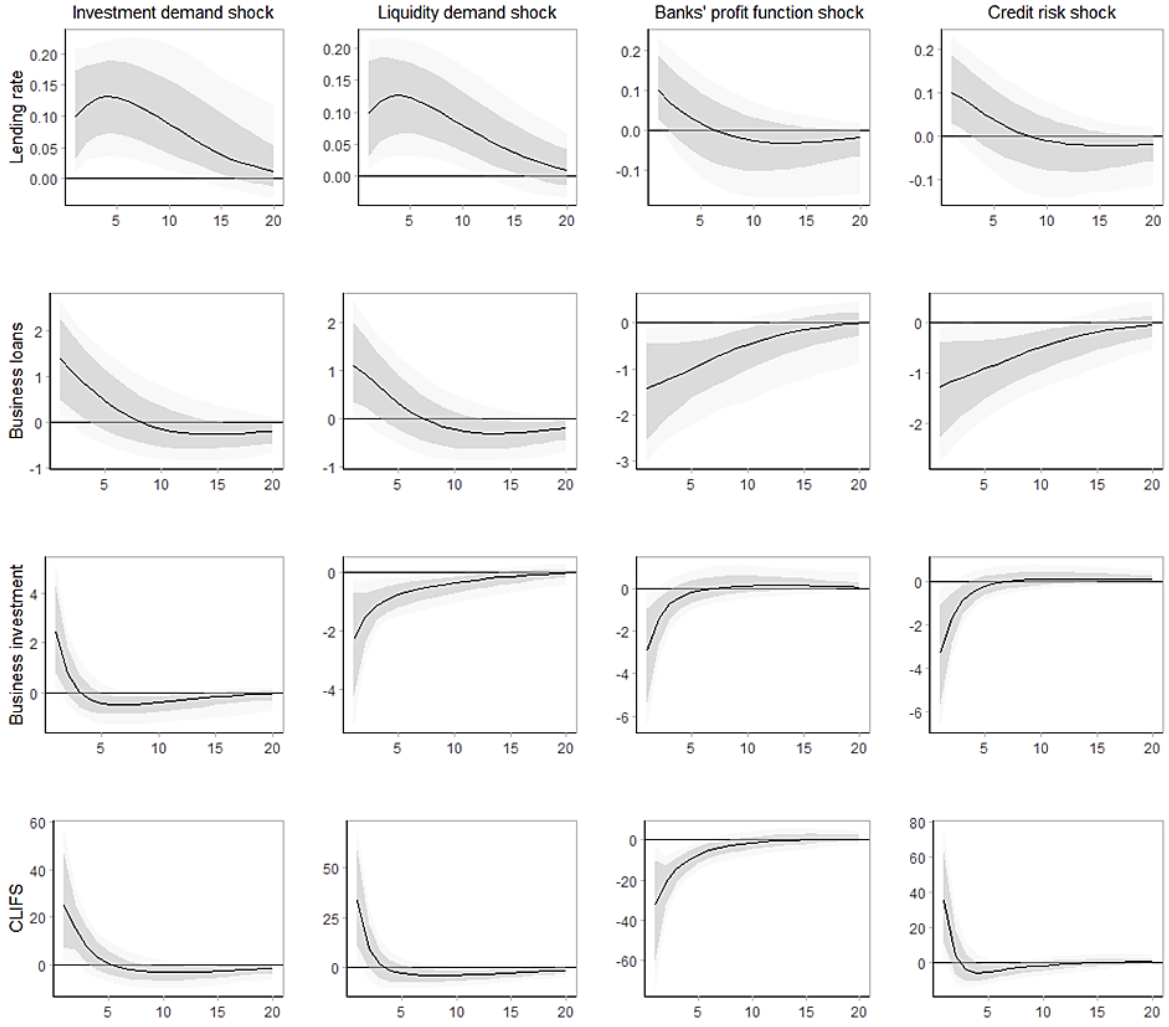
With the estimation of the impulse response functions, we observe the median responses of endogenous variables in the BVAR model to the structural shocks. It is noteworthy that the impulse responses are scaled to the ten b.p. increase in the lending rate on impact. The posterior median of the impulse responses, together with the 68% and 90% confidence bands, are presented in Figure 4.7. While the signs of the responses are determined by means of identification strategy, the shape of the impulse responses are data-driven and can give us valuable information regarding the duration and magnitude of the structural shocks' impacts.

The responses of lending rate and the changes in outstanding loans can be roughly differentiated by the loan demand and loan supply shocks as the responses remain relatively similar within these two classes of shocks. It can be noted that the loan demand shocks' effect on the lending rate lasts longer and also reaches peak impact at approximately five quarters. In contrast, supply-side shocks affect the lending rate only temporarily. Both classes of shocks have a quantitatively similar effect (but with the opposite sign) on the changes in outstanding business loans. The only notable difference is

[15] The results of the estimated coefficients and the specification tests are reported in Appendix 8.

in the case of a liquidity demand shock, which appears to increase the amount of loans less compared to the investment demand shock. This result would suggest that, on average, loans increase by approximately 0.3 p.p. less at the same increase in the lending rate, meaning, in a loose sense, that the lending rates on liquidity demand shocks react stronger compared to the investment demand shock.

Figure 4.7: Impulse response functions



Note: The solid lines represent the median impulse responses, and the shaded areas represent 68% and 90% confidence bands generated by 100,000 draws from a posterior distribution. Horizontal and vertical axes represent quarters after the initial shock and the variable responses in percentage points (except the lending rate, which is expressed in basis points), respectively. CLIFS refers to the country-level index of financial stress.

Source: Own work.

Business investment is negatively affected by the positive liquidity demand shock. The median response is similar in magnitude to the investment demand shock. However, the response of the business investment remains statistically significant for a longer period. A comparison of the responses to banks' profit function shock and credit risk shock sheds

some light on the difference between the two. Although the changes in the credit market equilibrium are similar, we can observe some differences in the case of business investment. Supply shocks that can be justified by the increased credit risk decrease the business investment by 0.3 p.p. more compared to the banks' profit function shocks. The reason for the difference can be a reaction of the investment demand directly to the financial market uncertainty shock.

4.4.2 Forecast error variance decomposition

With the estimated structural BVAR model, we can address the issue of the relevance of structural shocks through the lens of the forecast error variance decomposition (FEVD). Specifically, we want to obtain the explained share of the forecast error variance or prediction mean squared error by a particular shock. In the framework of the credit market, we are interested in the relevance of identified shocks for the endogenous variables in the reduced-form BVAR model. It is worth noting that the explained variations do not sum to 100% as other factors may be responsible for residual variation in the series. We do not address this part of the variation as it is out of the scope of this analysis.

The lending rate for non-financial firms is predominantly affected by credit demand shocks in the short run, while in the long run, credit supply shocks catch up with them and explain a very similar share of forecast error variance (Table 4.2). Identified shocks explain only 63.9% of the short-run variation in the lending rate but increase substantially over the four-year horizon.

Table 4.2: Forecast error variance decomposition of lending rate for non-financial firms (in %)

	Q1	Q2	Q3	Q4	Y2	Y3	Y4
Investment demand shock	20.4	20.6	20.9	21.3	24.0	25.5	25.9
Liquidity demand shock	18.0	18.1	18.3	18.5	19.9	20.6	20.8
Banks' profit function shock	12.7	13.2	14.0	15.1	19.5	21.7	22.6
Credit risk shock	12.8	13.2	13.9	14.9	19.1	21.2	22.0
Sum	63.9	65.1	67.1	69.8	82.5	89.0	91.3

Source: Own work.

In contrast to the lending rate, credit supply shocks explain a significantly higher share of business loans than credit demand (Table 4.3). In the context of our theoretical framework, this notion would imply that the elasticity of the lending rate to credit demand shocks exceeds that of the credit supply shocks and vice-versa for the business loans. Hence, the results suggest that the credit demand function is flatter than the supply function.

Table 4.3: Forecast error variance decomposition of business loans (in %)

	Q1	Q2	Q3	Q4	Y2	Y3	Y4
Investment demand shock	18.1	17.9	17.8	17.9	18.9	20.5	21.4
Liquidity demand shock	10.4	10.2	10.3	10.5	12.2	14.0	14.9
Banks' profit function shock	26.5	26.5	26.5	26.5	26.5	26.7	26.8
Credit risk shock	24.1	24.0	24.0	24.0	24.3	24.7	25.0
Sum	79.1	78.6	78.6	78.9	82.0	85.9	88.0

Source: Own work.

However, business investment is the main focus of this analysis. Forecast error variance decomposition for the business investment shows that credit supply shocks explain only a smaller share of the business investment (Table 4.4). Such a result is consistent with Gambetti and Musso (2017). However, the decomposition of the credit demand shocks reveals the significant importance of the liquidity demand shocks as opposed to the investment demand shocks that explain only a minor share of forecast error variance. The relative importance of liquidity demand shocks hints at the notion that business investment in Slovenia primarily follows an excess in liquidity, while the investment demand curve seems, on average, relatively stable.

Table 4.4: Forecast error variance decomposition of business investment (in %)

	Q1	Q2	Q3	Q4	Y2	Y3	Y4
Investment demand shock	12.1	12.0	12.3	12.7	14.6	15.7	16.1
Liquidity demand shock	27.8	27.7	27.6	27.6	27.5	27.5	27.5
Banks' profit function shock	13.5	13.3	13.4	13.8	15.7	16.9	17.4
Credit risk shock	17.5	17.4	17.5	17.7	19.0	20.0	20.5
Sum	70.9	70.4	70.8	71.8	76.9	80.1	81.5

Source: Own work.

Banks' profit function shocks explain the largest share of the CLIFS variance over the entire horizon (Table 4.5). Such a result is expected, as the main economic downturn in our analysis has been caused by a decline in the financial market. Therefore, a strong banking sector with a high return on loans and a limiting loan policy is desired for stable dynamics of the CLIFS. Liquidity demand shocks explain the lowest share of the CLIFS, as non-financial firms increase their liquidity by crowding out the investment activity and not by increasing indebtedness. For inverse reasoning, investment demand shocks explain a higher share of variation of the CLIFS.

Table 4.5: Forecast error variance decomposition of the country-level index of financial stress (in %)

	Q1	Q2	Q3	Q4	Y2	Y3	Y4
Investment demand shock	19.1	19.3	19.5	19.7	20.4	20.8	21.2
Liquidity demand shock	13.7	13.7	14.0	14.3	15.1	15.6	15.9
Banks' profit function shock	19.5	19.8	20.1	20.3	20.8	21.0	21.2
Credit risk shock	15.0	15.3	15.7	16.1	16.8	17.2	17.5
Sum	67.3	68.0	69.4	70.5	73.0	74.6	75.8

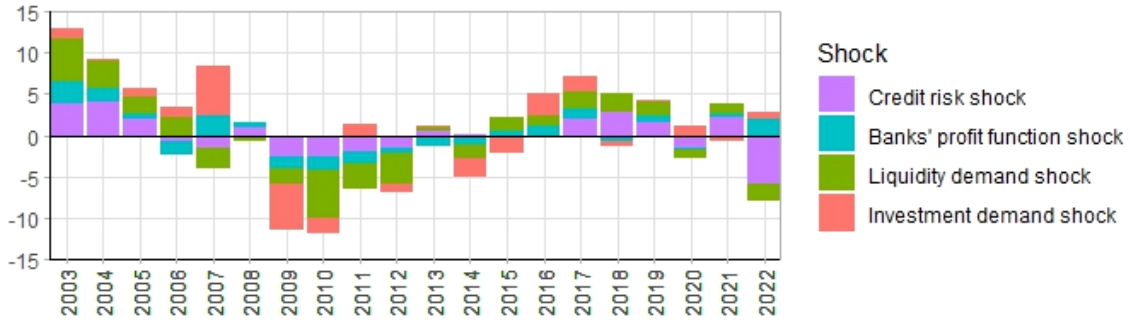
Source: Own work.

4.4.3 Historical decomposition of the business investment

In this section, we are interested in the historical contributions of structural shocks to the stochastic component of business investment. Unlike the impulse response functions and FEVD, which show unconditional expectations, the historical decomposition of the business investment shows the counterfactual development of the business investment in Slovenia if it would only be caused by a particular structural shock. In other words, we would like to know the cumulative effect of a particular structural shock on the business investment at every given time. Addressing the historical decomposition is essential for at least two reasons: (1) since our chosen identification strategy is based on sign restrictions, we need historical decomposition to evaluate the expediency of identifying restrictions, and (2) we are interested in the current and historical drivers of business investment in Slovenia. In the remainder of the section, we first study the main historical drivers of the business investment on the annual frequency. Furthermore, we shed some light on more interesting periods, the financial and sovereign debt crises (2009–2013) and the latest period of the COVID-19 pandemic and the military conflict in Ukraine.

Figure 4.8 presents the average annual contribution of identified shocks to business investment in Slovenia. Regarding the investment demand shocks, we can draw a similar conclusion as in the case of the FEVD of business investment. Over the period between 2003 and 2022, only a handful of significant investment demand shocks happened to affect business investment. Positive business investment shock contributions can be observed in 2007 and negative in 2009 at the beginning of the Great Recession. In contrast, it is evident that liquidity demand shocks played a significant role in the investment dynamics. Strong liquidity supported the investment at the beginning of the observed period and dampened it during the financial and sovereign debt crisis. Banks' profit function shocks were not a significant driver of the business investment. This result is important from the perspective of the usual definition of loan supply shocks that do not distinguish between the banks' profit function shocks and the credit risk shocks. Lastly, we observe that contributions of credit risk shocks are sensible as they exhibit a negative contribution during the great financial crisis, the COVID-19 pandemic, and the military conflict in Ukraine.

Figure 4.8: Historical decomposition of the business investment



Note: Annual contributions to the growth rate of business investment are approximated with the averages of quarterly contributions to the year-on-year growth rate.

Source: Own work.

Focussing in more detail on the financial and the sovereign debt crisis period, we aim for a more detailed explanation of credit market shocks contributions to business investment throughout the period of financial distress (Figure 4.9). We can see that business investment in Slovenia first experienced a substantial decline in 2008Q4/2009Q1, despite the beginning of the global financial crisis in 2007. The decline was initially driven by a strong negative investment demand shock, followed by a sequence of credit risk shocks, liquidity demand shocks, and banks' profit function shocks. Supply-side shocks in the credit market contributed a sizable part of the negative contribution to the business investment, consistent with Gambetti and Musso (2017).

Figure 4.9: Historical decomposition of the business investment during the financial crisis

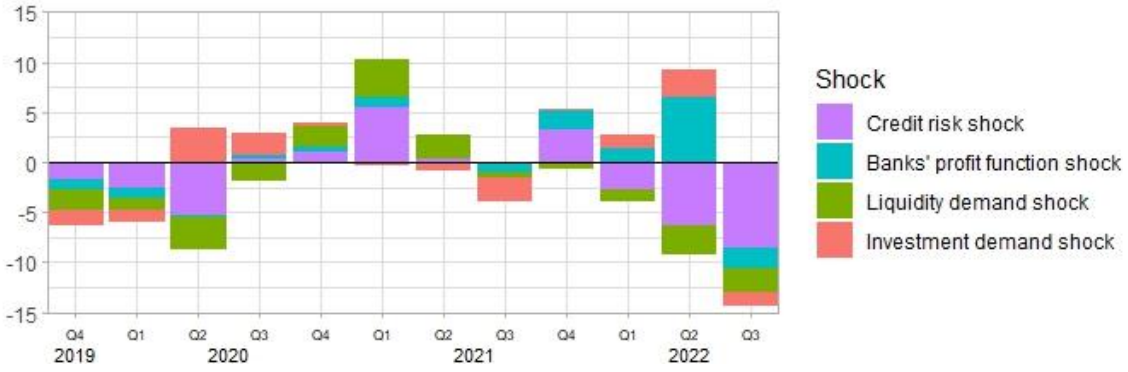
Source: Own work.

However, the differentiation between the credit risk shocks and banks' profit function shocks is crucial in this assessment, pointing to the fact that the vulnerable banking sector could not provide financing conditions to firms that were still demanding investment funding. The second ECB bond purchase program successfully untied the loan supply in

late 2011 and early 2012, creating favourable financing conditions. However, putting the supply shocks aside, the demand for liquidity appears to be the main factor that squeezed out the business investment in that period.

We further present the historical decomposition of business investment on the example of recent shocks that affected the Slovenian economy, namely the COVID-19 pandemic and the military conflict in Ukraine (Figure 4.10). Even though both shocks have non-financial origins, we want to present their effect on business investment through the lens of the credit market. Negative contributions to business investment during the period of economic distress unsurprisingly come primarily from credit risk shocks and liquidity demand shocks.

Figure 4.10: Historical decomposition of the business investment during the COVID-19 pandemic and the military conflict in Ukraine



Source: Own work.

4.5 Concluding remarks

In this chapter, we investigated the impacts of credit market shocks. Specifically, we investigated the fundamental innovations affecting loan demand and supply shocks. To address the question of existing theoretical drivers, we developed a comprehensive partial equilibrium theory of the credit market. Furthermore, we use the theoretically defined shocks to address the empirical questions related to the historical importance of different credit market shocks for business investment in Slovenia.

Our theoretical model is an extended framework of that of Kim et al. (1998), who have shown some potential advantages of liquidity holdings of firms in an environment with high lending rates. Our model is extended by the banking sector to describe and analyse the partial equilibrium of the credit market from the perspective of credit supply and demand. We have shown that the potential advantages of liquidity holdings magnify with credit market imperfections. Specifically, we show that optimal bank lending decreases if banks' expectations about the economic conditions worsen (so-called credit risk shock) or if the

banks' profit function changes (banks' profit function shock). Both shocks would be regarded as loan supply shocks in the existing literature, although their sources and economic impacts differ. On the demand side, we determine two types of loan demand shock: investment demand and liquidity demand shock. While the investment demand shock is well established, justification for the existence of liquidity demand shock itself points to imperfect capital markets and is, therefore, less frequently addressed in the literature. Our theoretical model shows that the possibility of liquidity holdings persists even in the case of its negative return.

Empirically, we found that loan supply shocks significantly affect business investment in Slovenia, where the predominant effect comes from the credit risk shock. Interestingly, the liquidity demand shocks alone explain more than a quarter of Slovenia's business investment variation. This result suggests that non-financial firms in Slovenia are not strongly financially constrained by the banking sector. However, they decided to hold the excess liquidity and delay their investment decision. Predominant effects of liquidity demand shocks are especially apparent during the Great Recession. In the latest period of the COVID-19 pandemic and the military conflict in Ukraine, we show that negative contributions to investment can be attributed to credit risk shocks and liquidity demand shocks, presumably in relation to the high financial uncertainty.

In terms of the credit market in Slovenia, we show that loan supply shocks are the main drivers behind the loan quantity variation, while loan demand shocks explain the majority of lending rate variation. This lateral result leads us to the assumption that the business loan demand is flat while the loan supply function is steep. The result is also evident from the impulse response functions.

These results are also interesting from the policy perspective. As loan supply shocks were viewed as partially responsible for the sharp decline in GDP and investment during the great financial crisis, our analysis shows that the most significant part of the limited supply can be attributed to credit risk shocks. Therefore, according to our methodology, exogenous banks' profit function shocks played only a minor role in business investment developments. According to our results, accommodative monetary policy could not stimulate investment activity in an uncertain environment. Thus, fiscal and monetary policies should act together to create a sustainable and lucrative economic environment that would allow firms to invest a part of their excessive liquidity. Furthermore, in the common monetary area, fiscal policy can implement country-specific measures to effectively address the business sector's expectations regarding the economy's medium- and long-run development.

Identification of the importance of liquidity demand shocks for business investment during the period of global financial crisis opens a space for further research on this topic. In the theoretical setting, the assumption of uniform distribution of production shocks could be extended to a more general notion of uncertainty. Furthermore, it is possible to relax the

assumption of the independent distribution of production shocks. The empirical evidence of the importance of liquidity demand shocks during the financial crisis opens a question about the underlying reasons. In our view, firms could acquire liquidity holdings simply because they deemed the investment too risky or because banks withdrew their liquidity lines, forcing them to hold the liquidity reserves.

5 FINANCIAL FRICTIONS IN A MACROECONOMETRIC MODEL: A COUNTERFACTUAL ANALYSIS FOR THE CASE OF SLOVENIA

5.1 Introduction

The Great Recession (2007–2009) affected the economies worldwide extensively and distorted the notion and understanding of the linkages between the real and the financial economy to a great extent. Specifically, the crisis again uncovered the significant role of the financial sector's (in)stability and the existence of financial frictions in driving the business cycle fluctuations. While the instabilities and imbalances of the financial sector may not be evident during the expansionary phases of the business cycles, their potential accumulation may come to light during the recessionary periods, resulting in intensified responses of the real macroeconomic aggregates to external shocks. Therefore, financial frictions affect the real economy only marginally during economic expansion. However, their negative effects come to light during adverse economic conditions, usually deepening the crisis.

Hence, the shared consensus is that the financial sector represents a vital part of the economy; consequently, it became popular to include it in large macroeconometric models. In the previous two decades, it has become obvious that modelling the effects of the financial market is crucial for prudent simulations of the future development of the economy and for capturing the effects of exogenous shocks on economic performance more thoroughly (Brunnermeier & Sannikov, 2014). The main problem of existing models is that they usually impose the validity of the assumption of perfect capital markets, a building block behind Modigliani-Miller's (1958) theorem of the irrelevance of corporate capital structure.

Such foundations of the econometric models often result in their inability to properly estimate the effects of potential shocks due to limited information regarding the transmission mechanism from the financial to the real sector. Ideally, the transmission of funds from savers to debtors through the financial sector would be smooth, especially during periods of economic distress. However, the financial sector is far from flawless, hence the necessity to appropriately model their inclusion in the macroeconometric models.

Therefore, the analysis in this paper aims to implement the transmission channels between the financial and the real economy in the existing macroeconometric model of a small open economy of Slovenia. For the estimation period 1999Q1–2019Q4, we collected additional data on business and residential investment, their respective lending rates, and companies' gross operating surplus and performed a counterfactual analysis in the sense of comparing the simulation results of the model with financial frictions to the results obtained from the model without their explicit modelling. Such an approach yields essential insights into the importance of modelling the financial sector in the macroeconometric framework.

Explicit modelling of the financial frictions may be even more relevant for the case of a small open economy such as Slovenia since forecasts and estimated coefficients may otherwise suffer from significant omitted variable bias. As in most developed countries, the period of the Great Recession can be classified as a period of severe economic and financial distress in the Slovenian economy. The period of significant GDP growth abruptly stopped in 2009 when the recorded contraction of economic activity amounted to 7.5%.

Despite a slight recovery during 2010–2011, the economy was hit by the second wave of the financial crisis, characterised as the sovereign debt crisis, in 2012 and 2013, when the real GDP growth amounted to -2.6% and -1%, respectively (SiStat Database, 2023). Although the crisis affected the overall economy, it can be extensively depicted by a credit crunch, a sharp contraction in lending, a decrease in foreign direct investment, and a sharp increase in non-performing loans.

The rest of the chapter is structured as follows. Section 5.2 provides an overview of the relevant literature on modelling financial frictions. Section 5.3 provides a brief overview of the recent financial market dynamics in the small open economy of Slovenia. Section 5.4 presents the empirical framework in the sense of a brief overview of the existing macroeconometric model, data description, and extensions of the model. Section 5.5 focuses on reporting and interpreting the results of the counterfactual analysis. Finally, Section 5.6 concludes the chapter.

5.2 Literature review[16]

Based on the outline of the phenomena of financial frictions, the interest in examining its underlying determinants and possible consequences for the overall economy usually arises during periods of adverse economic and financial shocks. An early example of such an occurrence goes back to the 1930s, a period of the Great Depression, which resulted in seminal contributions stressing the importance of financial frictions from the classical economists (e.g., Fisher (1933), Keynes (1936), and Minsky (1957)). Despite the relatively

[16] Extensive literature reviews on the effects of financial frictions are presented by Quadrini (2011), Brunnermeier et al. (2012), and Claessens and Kose (2018).

scarce contributions on this topic, the idea of examining the transmission channel between the financial and the real economy came to light with the outbreak of the Great Recession, when a bulk of literature started to examine the so-called financial accelerator mechanism.

This mechanism commonly pertains to the propagation and amplification of external shocks to the real economy through the financial sector. The research on this topic dates back to the work of Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke et al. (1996, 1999). According to Adam and Glocker (2018), the interactions between the financial market instabilities and real macroeconomic aggregates correspond to three distinct groups: 1) external shocks disrupt the business-as-usual private sector's behaviour, resulting in external distress in the financial market, 2) due to imperfect financial markets (i.e., the existence of financial frictions, imbalances, and other imperfections), the initial external shocks are subjected to the amplification mechanism originating in the financial sector, and 3) the financial sector is viewed as the source of distress, which transmits to the overall economy.

Since the contribution of Bernanke et al. (1999), a substantial strand of literature relied heavily on the adaptation of the dynamic stochastic general equilibrium (DSGE) methodology[17] in studying the effects of financial frictions (e.g., Elekdag et al. (2006), Christensen and Dib (2008), Merola (2015), Cavalcanti (2010), and Rubio (2020)). Despite being heavily popularised, DSGE models are prone to criticism in the sense of questionable assumptions (regarding the rational behaviour of individuals and companies), estimation methods (mix of calibration and Bayesian estimation), and poor performance during specific periods of financial distress (e.g., the Great Recession (Blanchard, 2018)). Furthermore, according to Hurtado (2013), the deep parameters in DSGE models might be, like other structural econometric models, subject to the Lucas (1976) critique.

An alternative approach to evaluating the effects of financial frictions is through their implementation in the Cowles Commission-type macroeconometric models. According to Fair (2015), such a modelling approach also allows accounting for the main endogenous features of the economy based on reasonable theoretical foundations. The latter is crucial for appropriately evaluating and explaining various policy effects and historical events of the economy and predicting the economy's future development. Examples of empirical applications include, for example, Hammersland and Træe (2014), Adam and Glocker (2018), and Benedictow and Hammersland (2020).

The origins of the financial frictions lie in the information asymmetries between the financial and real economy stakeholders. Such asymmetries are often the main cause behind the variation in the external finance premium, representing the markup on the cost of the non-financial sector's internal finance. The external finance premium tends to increase during economic downturns as a response to higher risks associated with lending

[17] For the earliest contribution to this approach, see Prescott (1986) and Smets and Wouters (2007) for a standard reference model.

opportunities by, typically, the banks. To a great extent, the implementations of financial frictions pertain to the automatic adjustments of the lending rates and are used by, for example, Brayton et al. (2014) and Angelini et al. (2019).

In contrast, the transmission channel through which the issue of financial frictions arises comes through the additional discretionary measures undertaken by the financial sector or the monetary authority (e.g., credit rationing) as a response to the overall state of the economy or its financial sector. The existing models with the explicit incorporation of financial frictions primarily focus on the transmission channel of lending rates as the pass-through of loans is difficult to capture. With this notion in mind, the primary focus on lending rates may underestimate the effect of financial shocks on the real economy. However, there have been several attempts to explicitly outline the effects of credit rationing on the real economy, for example, Greenwald and Stiglitz (1990) and Boissay (2001).

5.3 The financial sector in Slovenia

In the previous two decades, the Slovenian financial sector faced significant turmoil due to the heightened risks associated with the Great Recession and its structural flaws. During the period before the adoption of the euro currency on 1 January 2007, the Slovenian economy exhibited a favourable economic climate, denoted by positive growth in the macroeconomic aggregates and stability of its financial sector. Throughout this period of prosperity, the total financial liabilities of households and non-financial companies were increasing significantly, placing levels of indebtedness at 28% and 79% of GDP in 2007, respectively (Bank of Slovenia, 2008). Such a trend indicated a growing interest rate risk.

An important aspect that significantly outlined the period before the Great Recession is the non-financial companies' growing demand for external finance needed for the rising investment demand to be met. The consequent loan approvals pushed the companies' financial leverage (i.e., debt-to-equity ratio) to higher levels, amounting to, on average, 133% in 2006 (Bank of Slovenia, 2008). Accompanied by the companies' rising levels of financial leverage, the domestic banks' exposure to credit risk was also intensified due to the shifts in the companies' debt structure, which became greatly oriented towards domestic banks. As a response to the greater risks connected with the rising indebtedness of the private sector, the banks started to increase the risk premium for certain stakeholders (Bank of Slovenia, 2007). In contrast, the upward trend of reductions in the credit standards and shares of uncollateralised loans continued until the outbreak of the Great Recession.

The Great Recession (2007–2009) initially affected the Slovenian financial sector, particularly banks, only indirectly. The driving force of the significant economic growth in the pre-crisis era was mainly the remarkable investment demand. Due to the substantial levels of the non-financial sectors' indebtedness and decreased savings levels in the

economy, Slovenian banks relied heavily on funding from the international financial markets, which was truncated as a response to the financial crisis (Bank of Slovenia, 2009). Limited sources of funding and declining economic activity (causing the difficulties of debt repayment by the non-financial sectors) instigated significant structural changes in the banks' balance sheets. The banks were, therefore, faced with liquidity issues, which were addressed by expanding the deposits of the non-financial sectors, limiting the loan supply, and utilising the additional funding provided by the Eurosystem.

Despite a slight recovery during 2010 and 2011, the economy was hit with a second wave of economic and financial distress in 2012, severely affecting the non-financial companies and the banking sector. As the economic prospects worsened yet again, the Slovenian companies found themselves in a miserable state. On the one hand, declining economic activity caused lower profitability and investment demand. On the other hand, the companies struggled with obtaining the external funding needed to overcome the hardships in their daily activities as a result of significant indebtedness. Therefore, the companies were forced to undergo a difficult process of slow financial deleveraging (Bank of Slovenia, 2012).

As the percentage of non-performing loans increased, the banking sector's profitability dampened, and the need to restructure the bank funding expanded even further. In order to address the banking sector's vulnerabilities, the government implemented several measures, including establishing the Bank Asset Management Company (BAMC), which took over a large portion of the non-performing loans. According to the Bank of Slovenia (2015), the banking sector started to stabilise after the bank recovery and resolution process, combined with the improvement in the macroeconomic prospects in late 2014 and 2015. During 2014, the growth of the loans approved to the non-financial sectors started to increase; however, it did not reach the pre-crisis levels due to the restructuring of companies, which still exhibited the tendencies toward deleveraging and restricting the bank dependencies in seeking external funding.

The period following the second wave of financial distress can be, to a great extent, characterised as a period of improvement of the general macroeconomic climate, stabilisation of the financial sector, and enhanced capital adequacy of the banking and the non-financial sector. However, the low-interest rate environment has a limited impact on the investment activity of the non-financial sector, possibly resulting from lingering uncertainties and companies' lack of confidence to undertake significant investment projects in the aftermath of the significant financial distress.

The period of economic prosperity and stability in the financial sector seemed to be disturbed, to a certain extent, primarily in 2020, as a result of the global COVID-19 pandemic, and even further in 2022, in light of the Russian military invasion of Ukraine. The latter has increased macroeconomic and systemic risks; however, according to the

Bank of Slovenia (2022), the resilience of the banking sector to systemic risks in the sense of liquidity, solvency, and profitability remains at a medium to a high level.

5.4 Empirical framework

In this section, we start by presenting the existing quarterly macroeconometric model of a small open economy of Slovenia. In the following subsections, we provide a detailed description of the necessary additional data and the changes to the modelling strategies in the macroeconometric framework to capture and evaluate the effects of financial frictions on the Slovenian real economy.

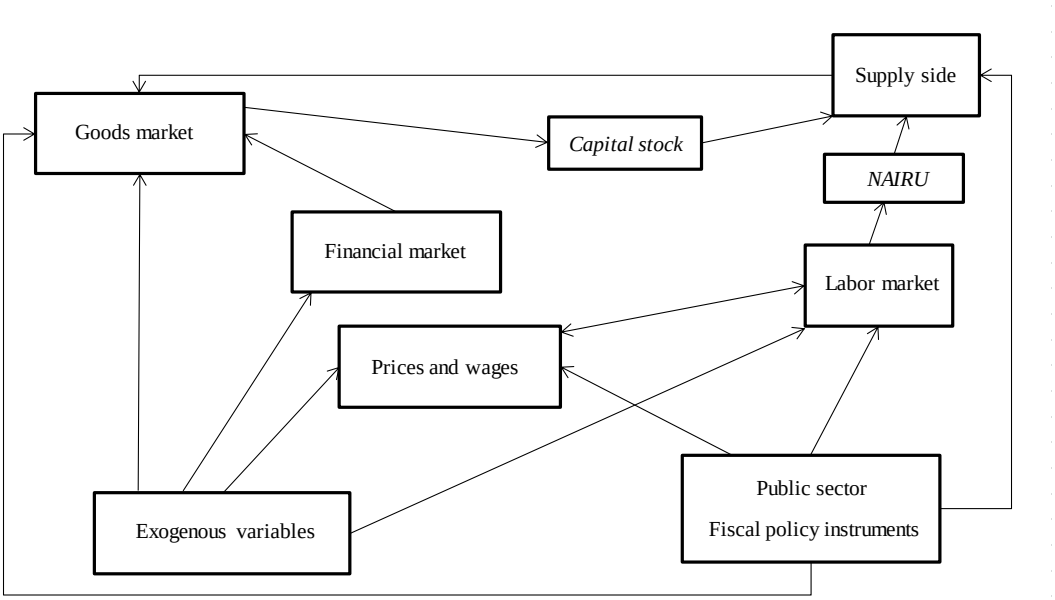
5.4.1 Macroeconometric model of the Slovenian economy

Evaluation of the effects of the financial frictions presented in this chapter builds upon the existing quarterly macroeconometric model of the small open economy of Slovenia, developed by Verbič et al. (2018) and Weyerstrass et al. (2018). It has already been utilised by several studies and policy analyses (e.g., Neck et al. (2018), Blueschke et al. (2019), Weyerstrass et al. (2020), and Neck et al. (2021)). A medium-sized Cowles Commission type model is typically used for policy simulations and forecasting the economy's future development, especially in the short and medium run.

In the most recent version of the model, the representation of the Slovenian economy is given by 73 equations, namely 21 behavioural equations and 52 identities, and an additional 37 exogenous variables serving as an external input to the model specification (Weyerstrass et al., 2022). The combination of the endogenous and exogenous variables yields an efficient portrayal of the economy by considering all the necessary aspects: the goods market, labour market, financial market, and public sector. The graphical outline of the model is presented in Figure 5.1, while the detailed description of the model and its properties are depicted in Weyerstrass et al. (2018).

By construction, the model encompasses the elements of Keynesian and neoclassical economics. While the model operates on a demand-driven basis in the short run, the long-run modelling of the economic development is leaned on the state of the supply side through the potential output. In the most recently updated version of the model, the behavioural equations are estimated on the quarterly data spanning from 1995Q1 to 2019Q4. Despite the data availability beyond the last quarter of 2019, the data are heavily driven by the COVID-19 pandemic, which significantly disrupted the trajectories of the macroeconomic development; hence, they were omitted from the estimation process (Weyerstrass et al., 2022).

Figure 5.1: Structure of the macroeconometric model



Source: Adapted from Weyerstrass et al. (2018).

The large dataset incorporates data that are mostly drawn from the Eurostat database and the CPB Netherlands Bureau for Economic Policy Analysis (see Neck et al., 2021). The stationarity tests, as presented in Verbič et al. (2018) and Weyerstrass et al. (2018), reveal that the model variables, as specified, are either stationary or indicate the presence of cointegration. The latter is reflected in the functional forms of the estimated equations, namely the error correction specification, which holds for the majority of the equations. The preferred estimator of the behavioural equations is the ordinary least squares (OLS) estimator, with the exception of the equations pertaining to the labour market, namely labour supply and labour demand, which are estimated as censored Tobit models.

While the model has been widely regarded as a reliable and valuable tool for policy simulations and the short and medium-run forecasting of economic development, it is important to stress the applications of the Lucas critique (1976), which is regarded as a common perplexity in the structural macroeconometric modelling context.[18] The critique suggests that the imposed relationships between the endogenous model variables are strongly dependent and influenced by the prevailing macroeconomic policy regime. However, to mitigate the concerns with respect to the underlying critique, the model combines economic theory to determine the long-run specifications and an analysis of time series properties to capture the dynamic aspect of the adjustment process. Moreover, the specification of the behavioural equations in error-correction terms involving cointegrated variables serves as a mechanism to efficiently combine the long-run equilibrium with the adjustment mechanisms operating in the short run (Neck et al., 2021).

[18] See, e.g., Neck et al. (2021) for a detailed discussion on this topic.

5.4.2 Data

For the purpose of this analysis, we enhanced the existing macroeconometric model by the inclusion of five variables: the lending rate for non-financial companies, the lending rate for households (mortgage loans), residential investment, business investment, and the gross operating surplus and other incomes. As discussed in the next subsection, the latter serves as a proxy for the non-financial companies' availability of internal finance. Given the data availability, the additionally collected quarterly time series correspond to the observed period 1999Q1–2019Q4.

In accordance with the existing version of the Slovenian macroeconometric model, the observed variables are expressed in real terms, for which we utilised the GDP and investment deflators for the transformation of the gross operating surplus and the two distinct types of investment, respectively. The summary statistics, additional transformations, and data sources are available in Table A67 in Appendix 9. Supplementary to the summary statistics, Table A68 in Appendix 9 presents the results from the performed Phillips-Perron tests for the time series stationarity, which indicates that the time series do not contain unit roots.

Furthermore, given the distinct nature between the lending rates pertaining to the various investment types, namely business and residential, we also constructed two additional identity equations for the investment-specific user cost of capital (UCC). They enter the estimation process as explanatory variables in their respective investment equations, presented in the next subsection. Apart from accounting for the specific lending rates, the differences in the UCC were also amplified by the differences in depreciation rates of housing investment vis-à-vis the business investments, which have significantly higher depreciation rates. Roughly in line with Angelini et al. (2019), the functional form of the user cost of capital for business investment ucc_nfc_t is the following:

$$ucc\_nfc_t = \frac{invdef_{t-1}}{gdpdef_{t-1}}\left(cl\_nfc + \delta_{nfc} - (1-\delta_{nfc})\left(\frac{\frac{invdef_t}{gdpdef_t} - \frac{invdef_{t-1}}{gdpdef_{t-1}}}{\frac{invdef_{t-1}}{gdpdef_{t-1}}} \right) \right) \tag{5.1}$$

where $invdef_t$ and $gdpdef_t$ represent the investment and GDP deflator, respectively, cl_nfc_t refers to the lending rate for non-financial companies, and δ_{nfc} represents the depreciation rate for the capital stock of the non-financial companies, which is calibrated at 10%. Analogously, we construct the user cost of capital for residential investment ucc_hh_t in the following way:

$$ucc\_hh_t = \frac{invdef_{t-1}}{gdpdef_{t-1}}\left(cl\_hh + \delta_{hh} - (1-\delta_{hh})\left(\frac{\frac{invdef_t}{gdpdef_t} - \frac{invdef_{t-1}}{gdpdef_{t-1}}}{\frac{invdef_{t-1}}{gdpdef_{t-1}}} \right) \right) \tag{5.2}$$

where cl_hh_t represents the lending rate for households, and δ_{hh} the depreciation rate for the capital stock of the households, which is calibrated at 3%.

5.4.3 Estimated equations and the counterfactual analysis

In the most recent version of the macroeconometric model of a small open economy of Slovenia, private investment is modelled as a single equation. To estimate the effects of financial frictions on the Slovenian real economy, we decomposed the private investment into business and residential investment to explicitly account for the possible differences of the spillover effects of distinct types of incomes, as well as differences in the corresponding lending rates. The lending rates for non-financial companies (cl_nfc_t) and households (cl_hh_t) are modelled in annual differences and represent a linear combination of the annual differences of the short and long-term interest rates:

$$\begin{aligned}(cl\_nfc_t - cl\_nfc_{t-4}) = \beta_0 + \beta_1(cl\_nfc_{t-1} - cl\_nfc_{t-5}) + \beta_2(gov10y_t - gov10y_{t-4}) + \\ + \beta_3(sitbor3m_t - sitbor3m_{t-4}) + \varepsilon_t\end{aligned} \tag{5.3}$$

$$\begin{aligned}(cl\_hh_t - cl\_hh_{t-4}) = \beta_0 + \beta_1(cl\_hh_{t-1} - cl\_hh_{t-5}) + \beta_2(gov10y_t - gov10y_{t-4}) \\ + \beta_3(sitbor3m_t - sitbor3m_{t-4}) + \varepsilon_t\end{aligned} \tag{5.4}$$

where $gov10y_t$ represents the ten-year government bond yield, and $sitbor3m_t$ represents the three-month interest rate before euro area access and EURIBOR from 2007 onwards.

To capture the business incomes that may be related to the business investment, we included the real gross operating surplus, $gosr_t$, which reflects the available funds for the business investment, in the equation of gross fixed capital formation for the non-financial companies. The behavioural equation is estimated as follows:

$$\log\left(\frac{gosr_t}{gosr_{t-4}}\right) = \beta_0 + \beta_1 \log\left(\frac{demand_{t-1}}{demand_{t-5}}\right) + \varepsilon_t \tag{5.5}$$

where $demand_t$ represents domestic demand, defined as a sum of private consumption, gross fixed capital formation, government consumption, and foreign demand, approximated by the export of goods and services.

Finally, the gross fixed capital formation equations, capturing the investment activity of non-financial companies ($invpr_t$) and households ($invhr_t$), are the following:

$$\log\left(\frac{invpr_t}{invpr_{t-4}}\right) = \beta_0 + \beta_1 \log\left(\frac{invpr_{t-1}}{invpr_{t-5}}\right) + \beta_2 ucc\_nfc_{t-6} + \beta_3 \log\left(\frac{gosr_{t-1}}{gosr_{t-5}}\right) + \varepsilon_t \qquad (5.6)$$

$$\log\left(\frac{invhr_t}{invhr_{t-4}}\right) = \beta_0 + \beta_1 \log\left(\frac{invhr_{t-1}}{invhr_{t-5}}\right) + \beta_2 ucc\_hh_{t-6} + \beta_3 \log\left(\frac{incomer_t}{incomer_{t-4}}\right) + \varepsilon_t \qquad (5.7)$$

where ucc_nfc_t and ucc_hh_t represent the user cost of capital for business and residential investment, respectively, and $incomer_t$ represents the households' income. The estimates of the equations presented in this subsection and obtained by the OLS estimator are reported in Tables A69–A73 in Appendix 10.

The counterfactual scenario is based on the notion that the non-financial companies' and households' incomes strongly affect Slovenia's gross fixed capital formation. The income effect can reflect the investment opportunities, the so-called demand effect, or the imperfections in the financial markets. In the microeconometric literature, several attempts were made to disentangle both effects to unravel the effects of financial frictions on the macroeconomic dynamics (e.g., Gilchrist & Himmelberg (1995)). In our counterfactual scenario, we utilise the results from the previous chapter (Chapter 4) and apply them to the existing macroeconometric model of Slovenia. According to the historical decomposition presented in the previous chapter, we isolate the variation related to loan supply factors and simulate their effects in the counterfactual scenario. The step-by-step procedure is presented in the continuation of this section.

Such an approach allows us to obtain the approximated contributions of financial frictions to the macroeconomic dynamics in Slovenia without explicitly modelling the financial market within the structural model. The inclusion of loan levels in the model is problematic due to a significant lag in the transmission of loans to investment and due to the deleveraging process of Slovenian non-financial companies and households in the aftermath of the sovereign debt crisis. Furthermore, based on analysis in the previous chapter, business investment in Slovenia has historically deteriorated primarily through the liquidity demand factors, showing that financial market imperfections drive investment activity.

The counterfactual analysis within the quarterly macroeconometric model is based on the reduction of the coefficient that relates the income growth to the investment growth (parameter β_3 in equations (5.6) and (5.7)). Ultimately, the coefficient β_3 should reflect the changes in investment that are affected only by the changes in the investment demand, while the remainder is attributed to the contribution of financial frictions.

Our approximation of the transmission reduction factor (γ) is estimated as follows:

– We collect the time series of contributions of financial market shocks to the business investment (presented in Chapter 4).

– We estimate the pass-through of the gross operating surplus growth on the demand contribution to the business investment (β^*) by the linear regression.
– Finally, the approximated share of demand-driven investment is obtained as $\gamma = \beta^* / \beta_3$.

The share of the demand-driven investment γ accounts for roughly one-fifth of the overall income effect on investment. However, we apply the same reduction factor to the residential and business investment equation due to the lack of a better approximation.

5.5 Simulation results

In this section, we show the impacts of four exogenous shocks on the macroeconomic environment of Slovenia through the lens of the quarterly macroeconometric model of the Slovenian economy. In this analysis, the latest version of the model was enhanced by additional transmission channels that can explain the shock propagation mechanism through the rigid financial sector. Our main premise in this simulation stems from the notion of the strong dependence of investment on past incomes in the economy. Elevated impacts from the income side can be partially explained by the investment demand (i.e., shift in the production function); however, the majority of the impact running through the cash flow channel can be attributed to imperfect capital markets.

In the following subsections, we present the responses to four exogenous shocks that can potentially affect the Slovenian economy: the short-term interest rate shock, oil price shock, world trade shock, and the exchange rate shock. As presented in the previous section, we also show the responses to all four shocks in the counterfactual scenario of a limited pass-through from the income component of investment equations. It is worth noting that different shocks affect the real economy through different transmission channels. Thus, the presence of financial frictions can have different implications for macroeconomic development in dependence on the specific shock that affects the economy. Furthermore, even though the estimated structural shocks are scaled to represent a 10% increase in respective variables, they significantly differ in importance for the macroeconomic aggregates. Thus, this feature of economic shocks may partially alter the impacts of baseline and counterfactual scenarios.

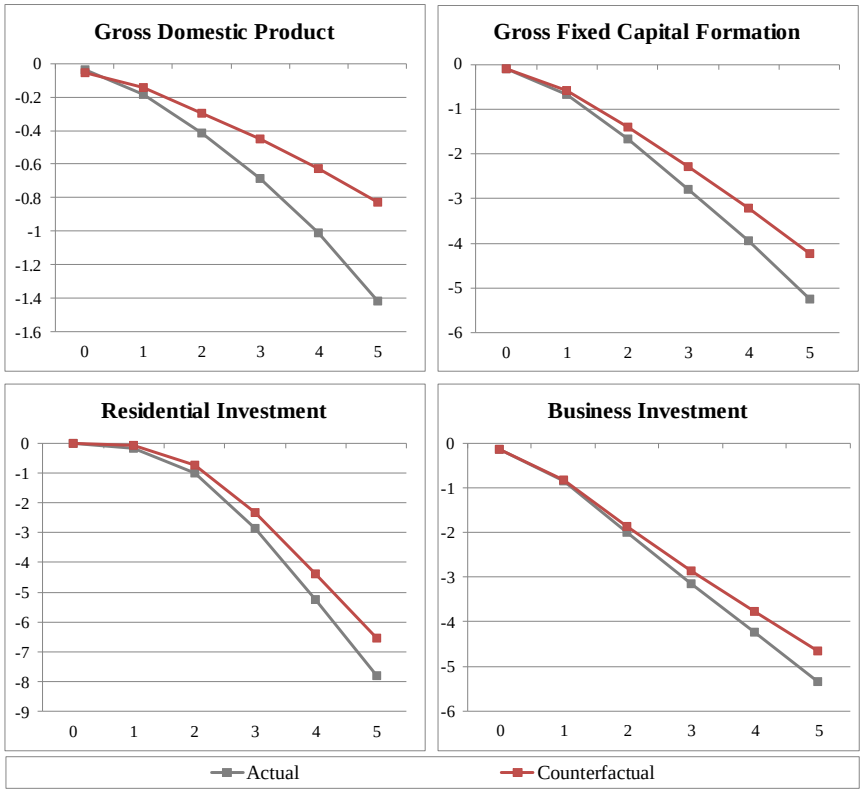
5.5.1 Impact of financial frictions on the real economy

Our simulation results pertain to real gross fixed capital formation, real residential investment, and real business investment, as they are primarily affected by financial market imperfections. Furthermore, we investigated the responses of the real GDP as its reaction is commonly described in the literature.

First, we simulate the response to a permanent 100 b.p. increase in the euro area short-term nominal interest rate, which is presented in Figure 5.2. Short-term interest rate increases the specific lending rates of residential and business investment, causing them to decrease as a response to increasing user costs of capital. The effect of the short-term interest is further accelerated through the impact on the long-term interest rate. The impact on the real GDP is additionally exacerbated through the lower private consumption, stemming from the lower levels of companies' and households' incomes.

From the comparison with the scenario of a limited transition of the income effect on private investment, we may observe the striking difference between the two responses. In the case of the demand-only reaction of the private investment to the short-term interest rate (denoted by counterfactual), business investment declines by approximately 1 p.p. less than in the case where we account for the financial transmission throughout the five-year period. Similarly, the effect on residential investment is relaxed by approximately 1.5 p.p. when disregarding the effects of financial frictions. It is noteworthy that the direct impact on the real GDP through real investment is estimated to be approximately 0.2 p.p. Differences between the impacts in both scenarios are broadly in line with the ECB Base model (Angelini et al., 2019) and the SIQM model (Damjanović, 2023).

Figure 5.2: Impact of the short-term interest rate shock (100 b.p.)

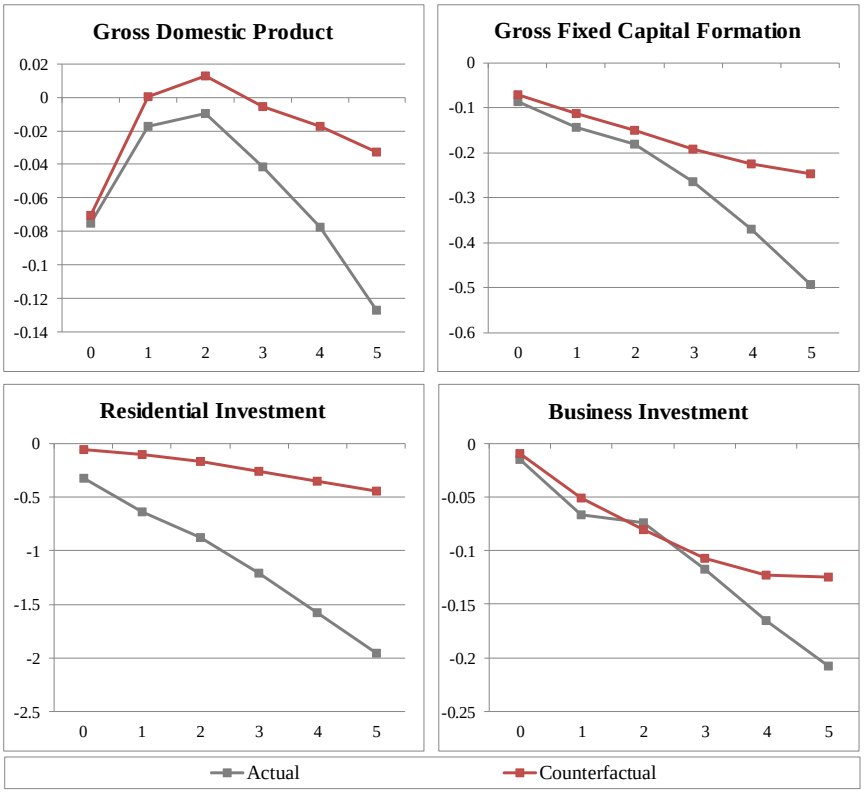


Note: Horizontal and vertical axes represent years after the initial shock and the percentage deviations of the variables from their baseline levels, respectively.

Source: Own work.

Figure 5.3 reveals that a permanent 10% oil price shock decreases the gross domestic product on impact by approximately 0.08% through the increased import prices. The real investment is only affected through the income channel since the lending rates remain untacked by the oil price shock. The impact that can be attributed to financial frictions is the largest in the case of residential investment due to the disproportionate impact on real incomes, while the non-financial companies' incomes remain more robust. However, in both cases, the effects of oil shocks are muted in case of restrictions on financial frictions.

Figure 5.3: Impact of the oil price shock (10%)

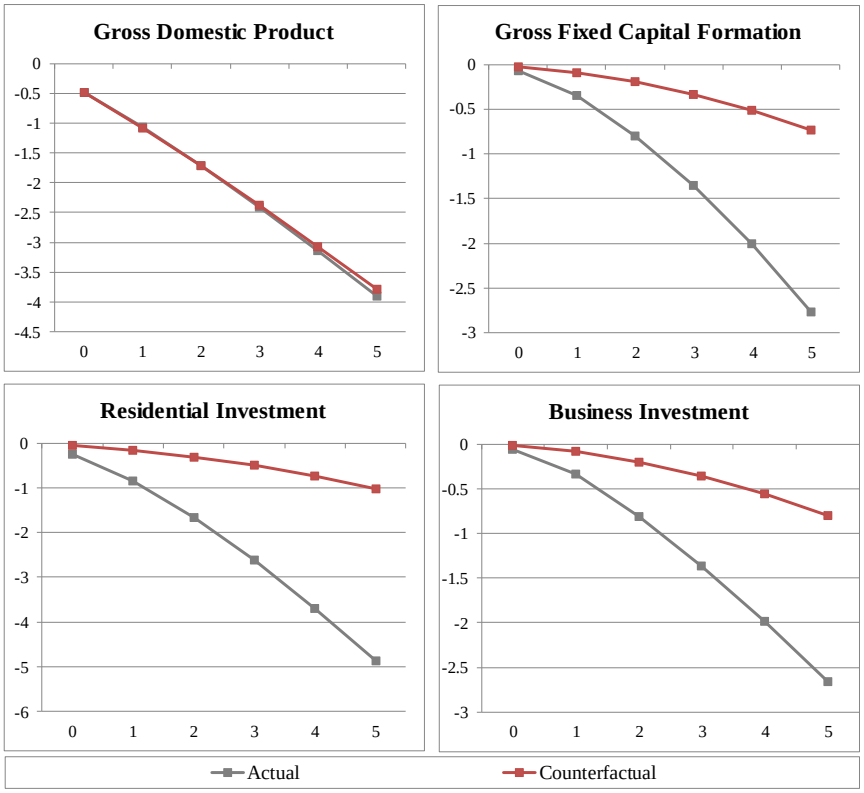


Note: Horizontal and vertical axes represent years after the initial shock and the percentage deviations of the variables from their baseline levels, respectively.

Source: Own work.

The impact of a 10% permanent decline in world trade strongly decreases the real GDP and the gross fixed capital formation, as may be observed in Figure 5.4. Similarly to the case of the oil price shock, real investment is only affected through the income channel of households and firms. We can observe more similarities between the reactions of the business investment vis-à-vis the residential investment as they both exhibit much milder impact in the case of limited financial frictions. It can be noted that the substantial change in world trade significantly decreases real investment, even in the case of limited financial frictions, presumably due to the changes in the production function that alters the investment demand. As can be observed from the figure, differences between the responses of the real GDP under both scenarios seem negligible.

Figure 5.4: Impact of the world trade shock (10%)



Note: Horizontal and vertical axes represent years after the initial shock and the percentage deviations of the variables from their baseline levels, respectively.

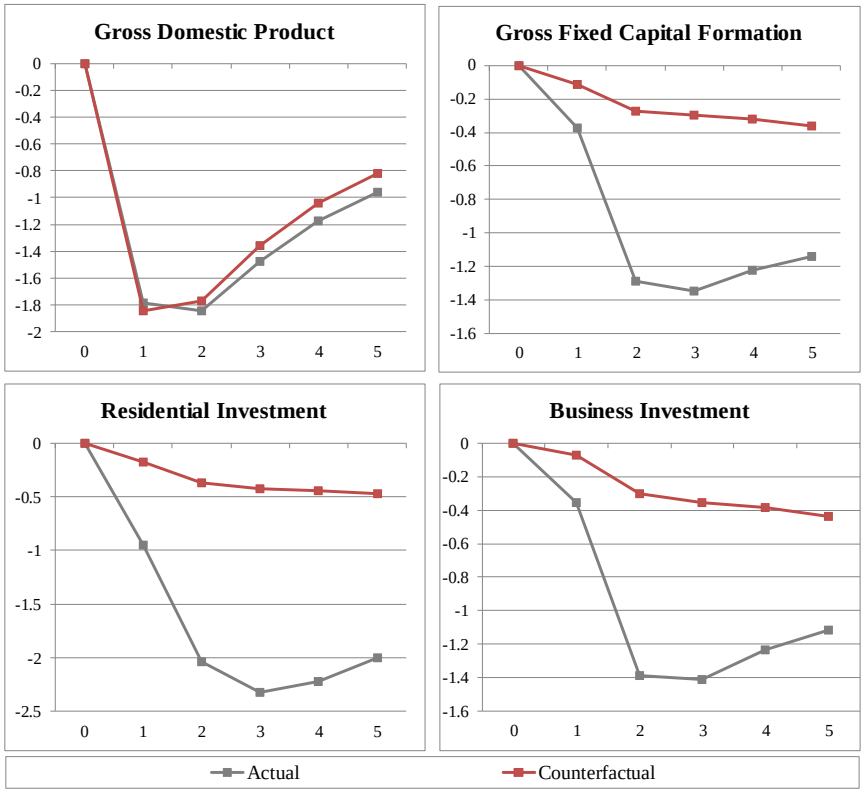
Source: Own work.

The real effective exchange rate shock represents a 10% appreciation of the euro vis-à-vis other currencies of trading partners of Slovenia. As evident from Figure 5.5, the worsening terms of trade contemporaneously decrease the foreign trade and thus the real GDP, which decreases by 1.8% over the course of the first year after the shock. After two years of a strong decline in real activity, the real activity begins to slowly pick up due to a mean reversion process. Investment activity is once again affected primarily through the income channel. Another channel of impact is from the increased long-term interest rates caused by the increased debt-to-GDP ratio. The differences between the actual and counterfactual scenarios are again evident, especially when observing the investment activity. The gross fixed capital formation cumulatively decreases by 0.8 p.p. less in the counterfactual scenario throughout the five-year period. The residential investment appears to be most affected, as the peak difference vis-à-vis the counterfactual scenario reaches almost 2 p.p.

Our simulation shows that the presence of financial frictions significantly reduces the resilience of the macroeconomic activity in cases of exogenous shocks. In the macroeconometric model, the financial push arises from the income channel of the investment activity. The motivation for such a structure comes from the early work of Gilchrist and Himmelberg (1995). Similar counterfactual studies often limit other

transmission channels, especially the lending rate mechanism (e.g., Bernanke et al., 1999). The empirical evidence for Slovenia suggests that the lending rates are driven mostly by investment demand factors. Thus, in this simulation, we aimed to incorporate both aspects by the restriction of the income channel from the perspective of a macroeconometric model.

Figure 5.5: Impact of the real effective exchange rate shock (10%)



Note: Horizontal and vertical axes represent years after the initial shock and the percentage deviations of the variables from their baseline levels, respectively.

Source: Own work.

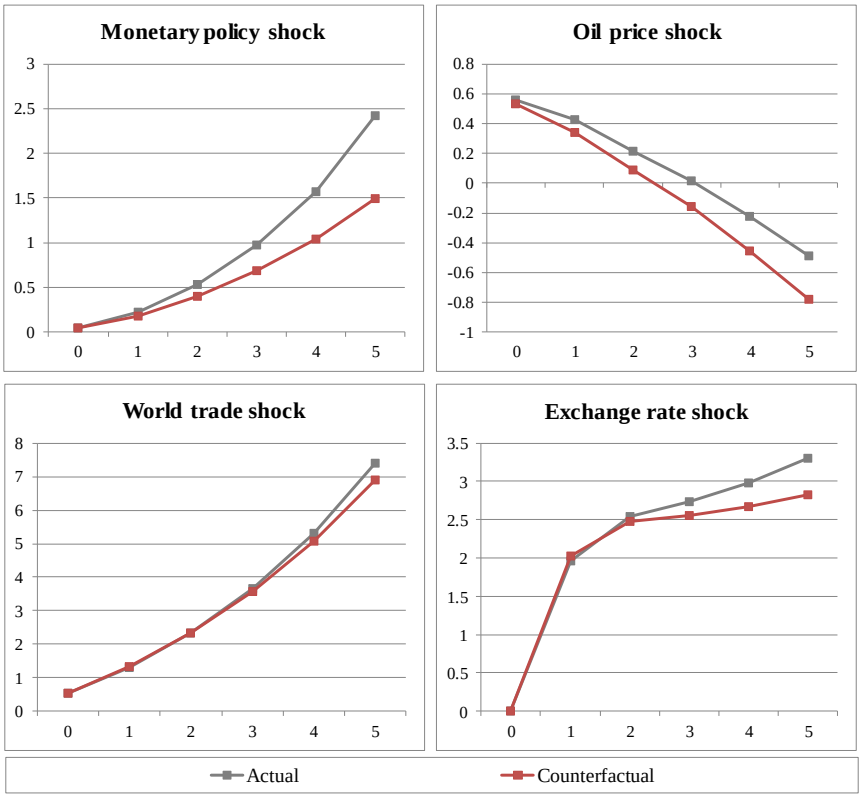
5.5.2 Impact of financial frictions on debt-to-GDP ratio

In this subsection, we aim to shed some light on the issue of government debt that arises after the emergence of negative exogenous shocks. Government debt usually arises due to increased public spending affected by automatic stabilisers and a simultaneous decrease in government revenues caused by adverse economic performance. The complexity of the transmission mechanism that affects this measure of the government's ability to act countercyclically led us to simulate the effects of exogenous shocks presented in the previous subsection to uncover the possible effects of financial frictions.

As we can observe from Figure 5.6, the presence of financial frictions contributes positively to the debt-to-GDP ratio in the case of adverse economic scenarios. The effect is

the strongest in the case of the monetary policy shock due to stronger interaction with the financial markets. In the case of the oil price shock, the long-term impact on the government debt is even negative, as the government revenues from taxes increase and the nominal GDP is boosted by the higher inflation rate. However, even in the case of an oil price shock, the scenario with the absence of financial frictions implies a more resilient fiscal stance. In the case of world demand shock and the effective exchange rate shock, the differences between the two scenarios are smaller, as the differences arise primarily from the investment activity, which only partially translates into the variables related to the fiscal position.

Figure 5.6: Responses of the debt to GDP ratio



Note: Horizontal and vertical axes represent years after the initial shock and the percentage deviations of the debt-to-GDP ratio from its baseline levels, respectively.

Source: Own work.

It is worth noting that the impacts of financial and uncertainty shocks may be extremely heterogeneous across countries. As noted by Tagkalakis (2013), heterogeneity is strongly dependent on the sources of funds for investment, the size of the financial sector, and the initial state of the government debt. Another important channel may be the heterogeneity of the financial accelerator contributions.

5.6 Concluding remarks

This chapter investigates the effects of financial frictions on the real economy. With the occurrence of significant financial distress in light of the Great Recession (2007–2009), the importance of inspecting and addressing the financial sector's vulnerabilities has (re)emerged. The events during the last two decades have proven the important role of the financial sector and the associated transmission channels as the drivers of the macroeconomic transition through different phases of the business cycles.

A prominent approach to investigating the impacts of financial frictions is their explicit modelling in the macroeconometric model setting. In the past, such models typically incorporated the validity of Modigliani-Miller's assumption regarding the perfect capital markets; however, the magnitude of the last financial crisis' consequences showed that the assumption is not relevant for prudent simulations of the future development of the economy and for capturing the effects of exogenous shocks on the macroeconomic environment.

The focus of this analysis is to strengthen the financial aspect of the existing quarterly macroeconometric model of a small open economy of Slovenia by the inclusion of the additional transmission channels through which the effects of financial frictions may affect the overall economy. By conducting the counterfactual analysis, we simulated the contribution of financial frictions to the acceleration of a macroeconomic downturn under the hypothesis of adverse exogenous shocks.

The results indicate that the macroeconomic variables react in accordance with the predictions of the underlying theory and the estimates of other macroeconometric models for Slovenia. The enhanced financial transmission channels contributed positively to the reactivity of macroeconomic variables on the financial shocks that increase the financing rates. We have also shown that the presence of financial frictions significantly affects the resilience of the Slovenian economy through both the pure macroeconomic perspective and the position of fiscal policy.

Financial frictions can affect the availability of credit and, thus, investment activity during periods of economic and financial distress. Policymakers can design lending programs that facilitate access to financing and limit the effects of financial accelerator. Furthermore, in the presence of financial frictions, fiscal policy needs to maintain the appropriate levels of public debt as it tends to increase under the influence of imperfect financial markets.

The transmission channels in the macroeconometric model are limited to the income and the lending rate channel, as we do not include the credit market equations. The main reasons for such a decision are the possible discrepancies between the credit demand and investment activity and the deleveraging process of Slovenian non-financial companies and households in the aftermath of the sovereign debt crisis. However, our approach implicitly includes credit rationing, liquidity demand, and uncertainty channels through the income

channel. It is worth noting that despite being cautious about including the most relevant information into account during the estimation process, structural changes in the economy and policy shifts may influence the estimated parameters and conclusions. To make our empirical conclusions useful within the context of a dynamic and evolving economy, the model should be frequently re-estimated and adjusted for variables, which may shed light on the structural changes observed in the economy.

6 REVISITING THE IMPACT OF FINANCIAL SHOCKS ON THE FISCAL POSITION OF EURO AREA COUNTRIES

6.1 Introduction

Throughout history, episodes of significant financial distress and their severe impacts on the real economy and the fiscal dynamics during and in the aftermath of such episodes may be observed. The most recent example is the Great Recession (2007–2009), whose impacts on the economies were the most severe after the occurrence of the Great Depression in the 1930s. On the one hand, the theoretical and empirical investigations of the transmission channels between the financial and the real economy seem extensive and commonly pertain to investigating the impact of shocks originating in the financial sector on the real economy or the amplification of the exogenous shocks by the financial sector, as the transmission of the shocks originating in the real sectors has been accepted as part of the standard macroeconomic theory (Foglia et al., 2011). A worthwhile group of such transmission channels is generally known as the financial accelerator mechanism, whose conceptualisation can be heavily attributed to the seminal works of Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke et al. (1999). On the other hand, the inspection of the consequences of the financial turmoil on the fiscal dynamics has been relatively scarce.

The period of the Great Recession was largely characterised by the stock market crashes, increased systemic risks, and the substantial number of bank defaults, necessitating governments to implement decisive measures aimed at sustaining economic activity and averting a collapse of the financial sector. Such interventions are crucial in stabilising the economy after the outbreak of crises and may generate significant direct and indirect fiscal costs. The latter emerge from the broader implications of the economic downturns and their consequent policy measures, as the truncated economic activity negatively affects the tax revenues and levitates government expenditures through the actions of automatic stabilisers.

In contrast, the direct fiscal costs represent the additional strain on public finance resulting from the government’s supplementary discretionary measures implemented to prevent further disruptions of economic activity. During the previous financial crisis, such interventions often included packages targeted toward stabilising the vulnerable financial

sector, such as capital injections for the banking sector, payments of called-upon guarantees, subsidies to non-financial companies, and payouts to depositors, among others (Tagkalakis, 2013). Hence, the necessity for fiscal stimulus in navigating financial crises and restoring financial stability is often substantial and reflected in primary deficits and, consequently, in rising public debt.

The substantial burdens of public finance associated with the financial crises are also evident within the euro area nations, specifically during the period of the Great Recession and the subsequent European sovereign debt crisis. Prior to the outbreaks of crises, specifically during the period of 2003–2007, the average outstanding gross debt-to-GDP ratio of the euro zone stood at 68.6% (European Commission, 2011). However, in 2008, despite a modest overall GDP growth rate of 0.4% (European Commission, 2013), this ratio began to surge. Nonetheless, public debt levels in the euro area escalated significantly from 2009 to 2014, surpassing an average of 94% of GDP across the observed countries (European Commission, 2015). This rise was primarily driven by automatic and discretionary measures implemented to stabilise the macroeconomic climate and address the challenges arising in the distressed financial sector. After 2014, when the economies in the euro zone started to exhibit the recovery process, the expenditure side of public finance was less burdened, and consequently, the public debt ratio started to fall (European Commission, 2017).

The objective of this chapter is to systematically present the impacts of the financial shocks on the fiscal dynamics in the currency union (i.e., the euro area) consisting of 20 countries. We estimate the structural panel vector autoregressive (SPVAR) model on a sample of data from 1995Q1 to 2019Q4 and identify the financial shock by a combination of sign and narrative restrictions that captures the Great Recession period and its dynamics. Endogenous variables include the country-level index of financial stress (CLIFS), real GDP, GDP deflator, general government debt, and government bond yield spreads, which enables us to implicitly model the dynamics of government debt-to-GDP ratio. The diversity of the countries, in the sense of, for example, GDP per capita, public debt rate, and size of a country and its financial sector, also enable us to investigate the underlying elements, which may significantly influence the magnitude of the additional pressures on the public finance, resulting from the instabilities and imbalances occurring in the financial sector.

The rest of the chapter is structured as follows. Section 6.2 provides a review of the most recent studies, with a focus on their findings. Sections 6.3 and 6.4 bring forth the details of the considered data and methodology applied, respectively. Finally, Section 6.5 discusses our findings, and Section 6.6 concludes the chapter.

6.2 Literature review

The complex and intertwined nature of the interdependencies between the real economy, fiscal position, and the financial sector implies the existence of various transmission channels through which the effects of financial shocks, or more generally, the financial market conditions, affect the fiscal dynamics. Hence, the latter effects can be evaluated from different angles by inspecting specific features and the macroeconomic dynamics within the economies worldwide. In this section, we aim to present the recent literature, which falls in the domain of our analysis, focusing on inspecting their objectives and main research findings.

While the Great Recession has strengthened the interest of researchers to investigate the fiscal costs arising as a response to the adverse conditions in the financial markets, the considered topic does not represent a novelty in the academic literature. An important contribution from the period preceding the last financial crisis in the observed research field was provided by Honohan and Klingebiel (2003). Based on the exhibited trends during the 38 systemic banking crisis episodes, their results indicate the compelling amount of fiscal stimulus targeted in pursuit of stabilising the banking sector, reaching as far as 50% of the GDP. Furthermore, the authors conclude that the financial burden boosts significantly in the case of continuous adoption of accommodative policies, such as partial recapitalisations, blanket deposit guarantees, and debtor bail outs.

Building on the results from Honohan and Klingebiel (2003), Claessens et al. (2005) further evaluate the effects of extensive costs of the banking crises on the fiscal position, as well as on the macroeconomic losses. Their main findings are centred on the negative aspect of accommodative policies during adverse economic conditions, in the sense of large-scale fiscal costs, which also stalls the macroeconomic recovery. Hence, the authors suggest that policymakers should primarily concentrate on improving the institutional framework, which lowers the financial and economic costs in periods of financial distress.

As mentioned, the outbreak of the crisis of 2007–2009 has significantly boosted the novel evidence regarding the impact of financial shocks on the fiscal position. As reported by Taylor (2014), the slow recovery process exhibited by the global economies can be attributed to the adoption of poor economic policies, which have become, as opposed to the observations from the previous period of financial distress, less predictable and more discretionary[19] and interventionist, generally pertaining to the set of activist fiscal policy measures (Auerbach et al., 2010). Despite the underperformance of the fiscal policy measures, the evidence suggests that the discretionary measures pertaining to the expenditure side of the public finance (Alesina, 2012) and interventionist policies targeted at the labour demand gap (Tcherneva, 2011; 2012) perform better, and put a lesser strain on the rising public debt.

[19] The estimates for the impact of discretionary fiscal policy measures uncover the acceleration effects on the GDP growth by up to 1.6 p.p. in the euro area countries (Coenen et al., 2012).

Furthermore, examining the cyclicality of the public debt and the endurance of each phase, also compared to the dynamics in the financial markets, yields conclusions regarding the longevity of the debt expansions, which tend to be more persistent during the periods following the overheating in the financial market (Poghosyan, 2015). According to Reinhart and Rogoff (2011), periods of banking crises often arise as a response to significant private debt increases, eventually leading to the deepening of the economic distress caused by the sovereign debt crisis, which puts additional pressures on the public debt sustainability, and manoeuvring space for the government to act counter-cyclically. In contrast, the attempts to reduce the outstanding level of public debt should be focused on increasing the primary balances, mostly through the expenditure side, unless the necessities for fiscal consolidations during adverse times are extensive. In such a case, a downward sloping trend of the public debt should also be driven by the undertaking of a government's revenue-enhancing measures (see, e.g., Baldacci et al., 2012).

The growing evidence suggests the existence of the asymmetric effects of financial shocks, as the negative shocks tend to affect the fiscal accounts more significantly, and the effects of positive shocks can be detected only slightly (Afonso et al., 2018; Budina et al., 2015). Moreover, the asymmetries in fiscal consolidation are not only evident in the cases of the nature of financial shocks but also in investigating the impacts across multiple countries. While Tagkalakis (2013) found a positive correlation between the financial sector's size and the costs of fiscal interventions after a financial shock, the studies by Lago-Peñas et al. (2020) and Lago et al. (2020) show positive implications of the fiscal decentralisation to the overall fiscal position, which tend to diminish as the vertical fiscal imbalances increase significantly.

In the literature, special attention is also devoted to examining the interrelatedness between asset prices and fiscal policy reactions. Eschenbach and Schuknecht (2002) and Tagkalakis (2011) find that the increases in asset and residential property prices positively affect the fiscal position through the wealth effects, capital gains, and turnover-related taxes, which alleviates the process of fiscal consolidation. Furthermore, during the attempts to stabilise the economy after the period of adverse economic conditions, the impacts of positive fiscal shocks on asset prices are more pronounced in small economies with a lower degree of openness (Agnello & Sousa, 2011).

With the widening debate regarding the hypothesis of significant interdependencies between fiscal dynamics and financial market conditions, the popularity of implementing transmission channels within the macroeconometric frameworks has been increasing significantly. It is worth noting that the eventuality of the Great Recession caused the transition of fiscal consolidation towards undertaking discretionary measures to a greater extent, which should also be reflected in its inclusion in the mainstream macroeconometric models (Ban, 2015). Given the novel dynamics within the transmission mechanisms between the financial markets and fiscal position, Fernández-Villaverde (2010) finds evidence in favour of the stabilisation of the economy through the expenditure side of

public finance, Kollmann et al. (2013) find evidence that almost 50% of the rise in public debt can be attributed to the banking shocks and increased government spending, and Dellas et al. (2010) investigate the impacts of the financial shock on the macroeconomic aggregates and the design of the optimal economic policies in the presence of financial frictions.

6.3 Data

Our dataset consists of five variables at a quarterly frequency spanning from 1995Q1 to 2019Q4. We follow De Santis and Van der Veken (2022) in exclusion of the COVID-19 crisis that may be subject to parameter instability. The endogenous dataset aims to capture the country-specific developments in the index of financial stress, government debt, spread between 10-year government bond yields and the 3-month Euribor, real GDP, and GDP deflator. Based on the Im–Pesaran–Shin test (Im et al., 2003) for the time series stationarity, we conclude that the endogenous variables do not contain unit roots. The summary statistics of our dataset and the results of testing for time series stationarity are reported in Tables A74-A75 of Appendix 11.

The country-level index of financial stress (CLIFS) is an indicator that we use to capture the country-specific uncertainty that typically increases after the occurrence of financial shocks. In our setting, financial shocks are not clearly distinguished from uncertainty shocks, as the financial shock may be a form of uncertainty shock. Thus, we utilise the CLIFS to account for its dynamic impacts on the real economy and fiscal dynamics as well as for the identification of financial shock.

Spreads between the long-term government bond yields and the 3-month Euribor interest rate show the term premium as well as the credit risk associated with a particular country. In our analysis, we are especially interested in the cross-country heterogeneity; thus, some other baseline could be used instead of a 3-month Euribor. Including long-term government bond yields is important to model the price of additionally issued debt securities.

In order to capture most of the fiscal policy dynamics in the most aggregated form, we decided to capture fiscal dynamics with only one variable: government debt. As our model includes the real GDP and GDP deflator as well, we implicitly model the development of the debt-to-GDP ratio. According to De Haan & Sturm (1997) and Afonso et al. (2018), among others, the government debt-to-GDP ratio is the preferred way to describe the fiscal policy position as it reflects government expenditure and revenue. However, it cannot be described as a policy variable, as the governments usually concentrate on the fiscal balance as opposed to government debt, which is a stock variable. Moreover, Afonso et al. (2018) noted that the debt-to-GDP ratio captures the discretionary and interventionist government measures that may not directly reflect in the fiscal balance. They include the

recapitalisation of the banking sector, which is important for the analysis of the fiscal position responding to financial shocks.

6.4 The empirical model

In this section, we describe the methodology that allowed us to assess the impact of financial shocks on the euro area countries. Following Pedroni (2013), we estimate a structural vector autoregressive model using panel data (SPVAR), which is well-suited for macroeconomic analysis of the euro area, as it allows the effects of structural shocks to be heterogeneous across countries. Furthermore, the approach allows us to transparently decompose the structural shocks into idiosyncratic and common components.

The SPVAR model allows one to address two challenges in performing the macroeconomic panel data analysis. First, macroeconomic data related to multiple countries usually exhibit substantial heterogeneity across individual members. The classical panel data treatment techniques cannot simply omit heterogeneity across countries since the heterogeneity is likely to also extend to the dynamic properties. Second, the model allows us to account for the common shocks as well as the idiosyncratic shocks. Euro area countries are related by the common monetary policy and international trade; thus, the common structural shocks may affect all countries simultaneously. However, due to the abovementioned heterogeneity, the idiosyncratic components may contribute a substantial part of the dynamics. A common identification approach for a panel of countries allows us to extend the argument into the cross-sectional analysis of impulse responses to shed some light on the possible reasons for the existence of cross-country heterogeneity.

Other forms of panel VAR models follow the idea of dynamic panel data econometrics (typically large N and relatively small T) rooted in the GMM estimation under the assumption of homogeneous dynamics. This class of models typically follows the idea of Arellano and Bond (1991), who also described problems with estimation consistency under the case of dynamic heterogeneity. Under the explicit assumption of heterogeneous dynamics across countries we want to recover, the model is unsuitable for our analysis. Recent literature on panel VAR models focuses on the Bayesian estimation methods (e.g., Canova and Ciccarelli (2013)). However, Bayesian panel VAR models are commonly represented in the reduced form, which does not allow us to identify the structural financial shocks prevalent during the Great Recession.

The modelling approach utilised in this analysis is based on Pedroni (2013). The SPVAR model is based on the traditional time series structural VAR literature, for which the impulse responses are based on orthogonal structural shocks and the restrictions on the dynamics. Furthermore, the model allows us to disentangle structural shocks into the common and the idiosyncratic components that are mutually orthogonal.

6.4.1 Representation and estimation of the structural panel VAR model

This section describes the representation and estimation of the structural panel VAR model. A detailed description of the approach is available in Pedroni (2013). We consider a panel composed of $i = 1, \ldots, N$ individual members (20 countries in our case), for each of which we observe a set of endogenous variables $m = 1, \ldots, M$ (five variables mentioned in the previous section). The time period for individual members of the panel spans over the period $t = 1, \ldots, T_i$, where the member-specific number of observations accounts for the possibility of an unbalanced panel. We denote the data points of the panel as $y_{m,it}$. Following Pedroni (2013), we accommodate fixed effects by demeaning our data, so that $z_{m,it} = y_{m,it} - \bar{y}_{m,i}$, where $\bar{y}_{m,i} = \sum_{t=1}^{T_i} y_{m,it}$.

We assume that a given number of unobserved structural shocks (ε_{it}) drives the variation of our dataset. As our analysis focuses on financial shocks, we consider a vector of N country-specific financial shocks.[20] Country-specific shocks are independently distributed over time but are usually cross-sectionally dependent. We decompose the country-specific shocks by noticing the factor structure:

$$\varepsilon_{it} = \theta_i \bar{\varepsilon}_t + \tilde{\varepsilon}_{it} = \begin{bmatrix} \theta_i & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \bar{\varepsilon}_t \\ \tilde{\varepsilon}_{it} \end{bmatrix} = \begin{bmatrix} \theta_i & 0 \\ 0 & 1 \end{bmatrix} \epsilon_{it} \tag{6.1}$$

$$E\left[\epsilon_{it}\right] = 0; \quad E\left[\epsilon_{it}\epsilon_{it}'\right] = \begin{bmatrix} \theta_i \Omega_{i,\bar{\varepsilon}} \theta_i' & 0 \\ 0 & \Omega_{i,\tilde{\varepsilon}} \end{bmatrix} \quad \forall i,t \tag{6.2}$$

$$E\left[\epsilon_{it}\epsilon_{it}'\right] = 0 \quad \forall i, s \neq t; \quad E\left[\tilde{\varepsilon}_{it}\tilde{\varepsilon}_{jt}'\right] = 0 \quad \forall j \neq i,t \tag{6.3}$$

Following Pedroni (2013), the estimation of the model and identification of structural shocks consists of the estimation of common ($\bar{\varepsilon}_t$) and country-specific shocks (ε_{it}), from which we are able to infer loadings θ_i and idiosyncratic shocks $\tilde{\varepsilon}_{it}$. Thus, the estimation procedure involves a separate estimation of 20 country-specific VAR models and a common VAR model based on average observations across countries.[21] We identify the set of structural shocks from individual VAR models to form a matrix ε, consisting of country-specific shocks and a common shock vector. We continue by computing elements of vector θ as a correlation between the common shock and individual country-specific shocks. Furthermore, we can use equation 6.1 to infer a matrix of country-specific idiosyncratic shocks ($\tilde{\varepsilon}$).

[20] We discuss the identification of financial shocks in Section 6.4.2.

[21] It should be noted that we allow for different lag truncation values in the estimation of country-specific VAR models. However, the BI criterion indicated using one lag for all countries.

The orthogonality condition applied to common and idiosyncratic shocks implies that $\Omega_{i,\tilde{\varepsilon}} = I - \theta_i\theta_i'$. We want to scale the variance-covariance matrices of all shocks to identity; thus, we rewrite equation 6.1 as:

$$\varepsilon_{it} = \theta_i\bar{\varepsilon}_t + \left(I - \theta_i\theta_i'\right)^{1/2}\tilde{\varepsilon}_{it}^{*}, \text{ where } \Omega_{i,\bar{\varepsilon}} = I \text{ and } \Omega_{i,\tilde{\varepsilon}^{*}} = I$$

The transformation normalises the variance of the idiosyncratic shocks so that idiosyncratic and common shocks are identical in size. With the described scaling, the country-specific impulse response functions to the unit shock, $A_i(L)$, can be expressed as a sum of impulse responses to the common shock, $\bar{A}_i(L)$, and the response to a particular idiosyncratic shock, $\tilde{A}_i(L)$.

6.4.2 Identification of the structural shock

In this analysis, we are interested in estimating the effects of financial shocks on fiscal dynamics. We revisited the period of the Great Recession, exacerbated in the euro area with the collapse of the Lehman Brothers bank in 2008. We build on the study of Tagkalakis (2013), who identified the financial shock using a dummy variable for the financial crisis. In this analysis, we identify the financial shock by the narrative and sign restriction to disentangle the financial shock from the set of other structural shocks that affect the endogenous part of the SPVAR model.

To identify a financial shock from the reduced form innovations, we have to find a suitable restriction matrix. In the context of sign restrictions, we identify the financial shock by assigning meaningful signs to a matrix of impacts of structural shocks. We follow Arias et al. (2014) in the sign restriction identification process and the contribution of Anatolín-Díaz and Rubio-Ramírez (2018) in the case of narrative restrictions.

Table 6.1: Identification restrictions

Variable	Sign restriction	Narrative restriction
CLIFS	+	2008Q3
General government debt	+	
Interest rate spread	+	
Real GDP	-	
GDP deflator		

Note: Signs in this table show the restrictions imposed on the impact matrix. Empty spaces indicate that no restrictions are imposed on a particular coefficient. Restrictions are imposed only on the impact. CLIFS refers to the country-level index of financial stress.

Source: Own work.

Table 6.1 shows the identification restrictions we impose on reduced-form innovations to recover them from country-specific financial shocks. In our model, relying solely on sign restrictions is insufficient for accurately identifying and recovering financial shocks. This is because both demand and uncertainty shocks would exhibit similar responses as financial shocks (in the sense of their sign) from the endogenous variables, making it difficult to distinguish between them. Combined with the narrative restriction of a hike in financial shock in 2008Q3 on the back of Lehman Brothers' bankruptcy, we provide a sufficient restriction to recover a meaningful financial shock. The idea is to compare euro area countries' responses and investigate the reasons behind the cross-sectional heterogeneity of responses to financial shocks.

6.5 Results

In this section, we present the main results of the SPVAR model. In the first part, we show the impulse response functions of the main variables of interest to a financial shock, specifically, the responses of the debt-to-GDP ratio (calculated from the responses of the government debt, real GDP, and GDP deflator) and spreads between 10-year government bond rates and 3-month Euribor. Impulse responses to a financial shock of real GDP, GDP deflator, and the CLIFS are shown in Appendix 12, and the estimation results for each country separately are presented in Appendix 13. In general, results suggest a significant amount of heterogeneity across countries. On the back of the SPVAR methodology, we analyse the cross-section heterogeneity of impulse responses for the observed countries in the second subsection.

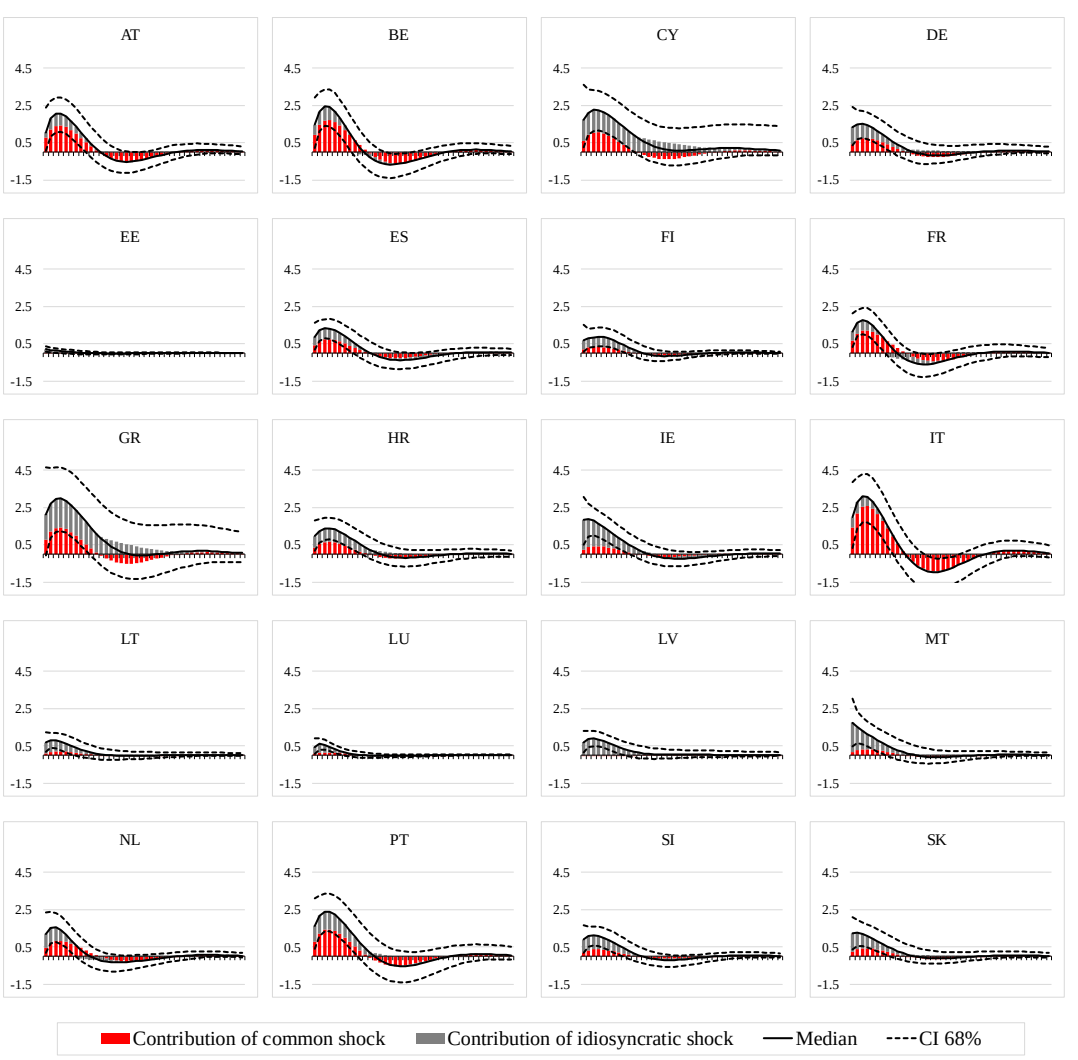
6.5.1 Impulse response functions

The reaction of the debt-to-GDP ratio to financial shock is shown in Figure 6.1. Considering the euro area average, financial shocks cumulatively increase the government debt-to-GDP ratio by 1.26 p.p. of GDP. The effects of a one standard deviation financial shock have a persistent effect on changes in the debt-to-GDP ratio, which remains elevated for a period of two years in the case of most countries. The obtained result is consistent with the findings of Tagkalakis (2013).

Responses of debt-to-GDP ratio exhibit significant heterogeneity across countries. According to our results, financial shocks have the strongest impact on the fiscal dynamics in Greece, Ireland, Cyprus, Italy, Belgium, and Portugal. It is worth noting that the impact of the debt-to-GDP ratio can be explained from two perspectives. First, the general government may force countries to finance their crumbling economies; therefore, additional debt must be issued. Second, due to an economic downturn, fiscal policy multipliers typically increase, making public expenditure a more desirable option for mitigating unfavourable economic conditions.

The common and idiosyncratic components give us additional information regarding the major contributions of financial shocks. In most countries, the idiosyncratic component significantly exacerbated the fiscal position. In the case of Greece, the idiosyncratic component contributed the majority of the debt-to-GDP ratio increase after the financial shock. In contrast, the Italian response can almost exclusively be attributed to the common factors. Such results can most likely be explained by the integration in global value chains, where Italy is integrated relatively more than Greece. We address the heterogeneity of responses further in the next subsection.

Figure 6.1: Responses of debt-to-GDP ratio to a financial shock (in p.p.)



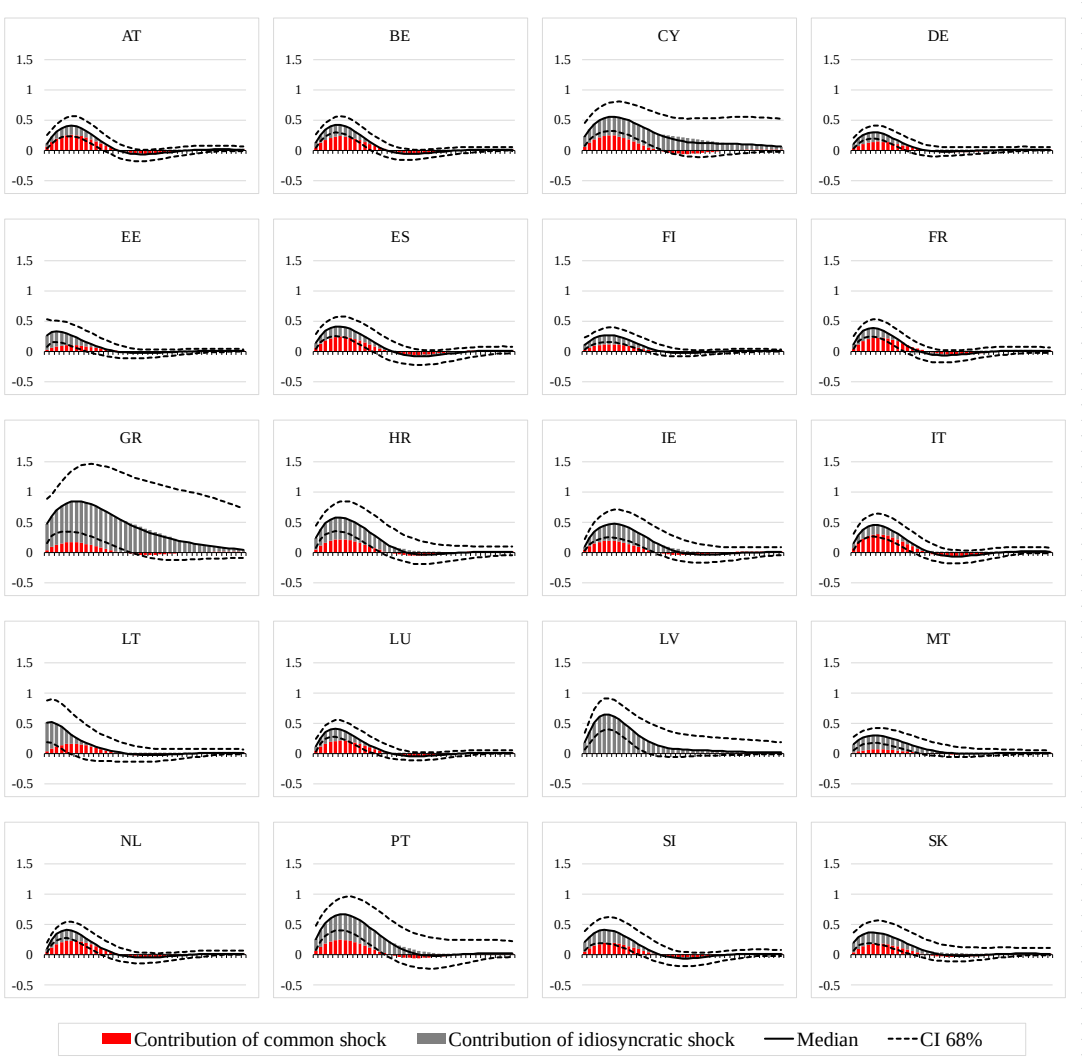
Note: AT – Austria, BE – Belgium, CY – Cyprus, DE – Germany, EE – Estonia, ES – Spain, FI – Finland, FR – France, GR – Greece, HR – Croatia, IE – Ireland, IT – Italy, LT – Lithuania, LU – Luxembourg, LV – Latvia, MT – Malta, NL – the Netherlands, PT – Portugal, SI – Slovenia, SK – Slovakia. Horizontal axes represent quarters after the initial shock.

Source: Own work.

The credit risk significantly affected government bond yield spreads after the financial crisis intensified in 2008Q3. Von Hagen et al. (2011) show that the government bond yield

spread differentials can still be explained by an economic rationale; however, shifts in market expectations require higher premiums on larger debt-to-GDP ratio levels. Attinasi et al. (2009) show that the higher levels of government debt and primary deficit play an important role in government bond yield spread. However, they advocate for further research into those impacts in light of country-specific financial sector data.

Figure 6.2: Responses of government bond spreads to a financial shock (in p.p.)



Note: AT – Austria, BE – Belgium, CY – Cyprus, DE – Germany, EE – Estonia, ES – Spain, FI – Finland, FR – France, GR – Greece, HR – Croatia, IE – Ireland, IT – Italy, LT – Lithuania, LU – Luxembourg, LV – Latvia, MT – Malta, NL – the Netherlands, PT – Portugal, SI – Slovenia, SK – Slovakia. Horizontal axes represent quarters after the initial shock.

Source: Own work.

Impulse responses of spreads between the 10-year government bond rates and the 3-month Euribor rate, presented in Figure 6.2, exhibit similar cross-country heterogeneity as the debt-to-GDP ratio responses. Considering the euro area average, one standard deviation financial shocks on average increase the government bond yields by 0.4 p.p. with respect to the 3-month Euribor over the course of two years. The impact of the shock is persistent

in all countries and positively affects the government yield spreads at a minimum of five quarters (Latvia). The highest two-year average impacts are recorded for the cases of Greece, Croatia, Cyprus, and Portugal. During the last financial crisis, the spread between the German government bond yield and the Greek government bond yield increased by approximately 250 basis points, consistent with results from the SPVAR model (scaled to the appropriate shock size).

It is noteworthy that the common component of a financial shock has a very limited impact on country-specific government bond spreads. Therefore, as opposed to the debt-to-GDP ratio, the idiosyncratic component of financial shock is the main driver of government bond yield spread across euro area countries. In the next subsection, we explore the possible underlying reasons for cross-country heterogeneity in responses of debt-to-GDP ratio and government bond yield to financial shock.

6.5.2 Drivers of cross-country heterogeneity

In this section, we describe some possible drivers behind the diversified responses of government debt-to-GDP ratio and government bond yield spreads to financial shock. According to Pedroni (2013), one can apply the cross-section analysis of the impulse response functions to improve the inference from the SPVAR model. However, to this end, we use stepwise linear regression models to shed light on the drivers of the cross-section heterogeneity.

We collect the impulse response functions, $A_i(L)$, to a one standard deviation financial shock and calculate each country's average value for a two-year period. In this way, we form a vector of responses of size *N*. We aim to explain the cross-sectional differences across countries by stepwise linear regression models to uncover the country characteristics that affect their fiscal variable responses to a financial shock. Explanatory variables included in this part of the analysis are GDP per capita, a dummy variable for euro area membership, trade openness (defined as a share of export and import in the GDP), size of a country (in the sense of its population), the relative size of the financial sector (calculated as the share of financial sector's value added in total value added), and the level of debt-to-GDP ratio.

As the latest extensive financial shock occurred in late 2008, we collected the annual country-specific data from 2007, namely data that reflect the pre-crisis era. Utilising the SPVAR model allows us to separately address the responses to a common component of financial shocks and an idiosyncratic component. The results of our analysis are presented in Table 6.2.

From the perspective of the impacts of financial shocks on fiscal dynamics, we are primarily interested in responses to changes in the debt-to-GDP ratio, which serves as our main indicator of the fiscal policy stance. The level of debt-to-GDP ratio seems to be the

main identifier of a response to a shock. The causal reasons for it can be found from the perspective of servicing the existing debt and increased government bond yields. However, since our analysis does not imply causation, we would argue that the higher level of government debt implies generous fiscal policy schemes that exacerbate the public debt extensively in periods characterised by disruptions in the financial market. The level of debt-to-GDP ratio is less important from the perspective of the idiosyncratic component of financial shock. Country size seems to negatively affect the change in debt-to-GDP, so an increase in population by 1%, on average, decreases a change in government debt-to-GDP ratio by 0.35 p.p. over the course of two years. These results align well with the results of Brunhart (2022), who has shown that smaller countries are more susceptible to global economic shocks, while the underlying factors behind this conclusion remain uncovered.

Table 6.2: Estimates from the stepwise cross-country regressions

	Debt-to-GDP ratio			10-year government bond interest rate to 3-month Euribor spread		
	Total	Common	Idiosyncratic	Total	Common	Idiosyncratic
Intercept	0.34 (0.13)	-0.12 (0.10)	0.88 (0.28)	1.70 (0.48)	0.09 (0.02)	1.30 (0.48)
GDP per capita				-0.29 (0.12)		-0.24 (0.11)
Euro area member					0.05 (0.03)	
Trade openness			-0.22 (0.14)	-0.18 (0.05)		
Size		0.13 (0.09)	-0.35 (0.15)	-0.09 (0.05)	0.03 (0.02)	
Size of the financial sector				1.95 (0.61)		
Level of the debt-to-GDP ratio	1.94 (0.23)	1.41 (0.21)	0.60 (0.26)	0.21 (0.08)		
R^2	0.80	0.82	0.34	0.65	0.31	0.21
Adjusted R^2	0.79	0.80	0.22	0.53	0.23	0.17
F statistic	71.16	39.20	2.75	5.23	3.81	4.89
df	1; 18	2; 17	3; 16	5; 14	2; 17	1; 18
p-value	0.00	0.00	0.08	0.01	0.04	0.04

Note: Standard errors are reported in the brackets.

Source: Own work.

Government bond yield spread responses are negatively associated with GDP per capita and trade openness, while the country size is not statistically significant. From the perspective of financial shocks, the relevance of the financial sector is a big contributor to government bond yields. A 10 p.p. increase of value added in the financial sector vis-à-vis the total value added would, on average, increase the government bond yield by 19.5 basis points.

6.6 Concluding remarks

In this chapter, we investigate the impacts of financial distress on fiscal dynamics, focusing on examining the euro area countries during the Great Recession. The observed period was primarily defined by significant stock market declines, heightened systemic risks, and a notable rise in bank failures. The adverse conditions compelled governments to take decisive actions to maintain economic activity and prevent a complete collapse of the financial sector. Unlike previous financial crises, the attempts to stabilise the economy were not focused primarily on the responses of the automatic stabilisers, as the extent of the crisis required undertaking significant discretionary and interventionist government measures. Such fiscal interventions are vital for stabilising the economy in the wake of crises, but they can result in substantial fiscal costs.

Our analysis is based on a structural panel VAR model of 20 euro area countries, analysed over the period from 1995Q1 to 2019Q4. The unique approach of the macroeconomic SPVAR model set forth by Pedroni (2013) enables us to transparently model the cross-country heterogeneity through the lens of different effects of common shocks, as well as idiosyncratic shocks, on a system of endogenous variables. Furthermore, the panel structure of the model enables us to investigate the heterogeneous responses to one standard deviation financial shocks by accounting for the characteristics of the euro area members.

Our results show that the government debt-to-GDP ratio responses are very heterogeneous across countries, as the two-year effects range from a 0.1 p.p. increase in the case of Estonia to 2.6 p.p. in the case of Greece. In most countries, the idiosyncratic component importantly exacerbated the fiscal position. In the case of Greece, the idiosyncratic component contributed the majority of the debt-to-GDP ratio increase after the financial shock. On the contrary, the Italian response can be almost exclusively attributed to the influence of common factors. The government bond yield reaction is similarly heterogeneous across countries, as the two-year spread increase ranges from 0.22 p.p. in the case of Finland to 0.73 p.p. in Greece. The idiosyncratic financial shock is the main driver of cross-country heterogeneity of government bond yield spread across the euro area countries.

The heterogeneity of changes in government debt-to-GDP can be explained primarily by the level of debt-to-GDP in the period antecedent to the financial shock. The reasons for heterogeneous responses of the government bond yield spreads are much more versatile. We find that the larger country size, trade openness, and GDP per capita contribute negatively to the government bond yields, while the relative importance of the financial sector and the debt-to-GDP ratio are significant positive contributors to the level of government bond yield.

The severe consequences of the adverse financial conditions on the fiscal position imply the necessity for cautionary and effective policy measures undertaken to stimulate the economy's recovery process. During the period of financial distress, governments should implement short-term discretionary and interventionist measures, which should be targeted, temporary, and designed to minimise the pressures on the rising government debt-to-GDP ratio. Furthermore, during the expansionary phases of the business, the governments should enforce strict fiscal discipline in attempts to decrease the level of public debt, monitor systemic risks, and regularly evaluate the financial market conditions to prevent future financial crises. While our discussion pertains to the optimal policy state or policy response in light of financial shocks, it is also worth noting that the simultaneous occurrences of additional non-financial economic shocks or the general economic and political environment may yield different conclusions. However, the latter is not within the scope of our analysis.

7 CONCLUSION

7.1 Main findings

Strong interdependencies between the financial sector and the real economy paved the way to research the transmission channels between the two. This dissertation focuses primarily on financial market imperfections and the amplification mechanism that arises from the presence of imperfect financial markets. In the second chapter, we present a comprehensive summary of the research field, focusing also on the content analysis of the most influential articles. The third chapter utilises a firm-level panel of non-financial companies that allows us to assess the presence of the balance sheet effects that constitute the impacts of financial frictions on investment dynamics. Furthermore, we analyse the effects of cash flow shocks on companies' outstanding debt ratio to test the hypothesis of the positive relationship between the cash flow and the availability of external financing. The results show that the bank lending channel is not a limiting factor of business investment in Slovenia. The presence of balance sheet effects was further investigated from the macroeconomic perspective. We estimated a theoretically founded structural BVAR model from which we concluded that liquidity demand is the main factor behind the discrepancy between the theoretically optimal investment and the actual realisation.

Imperfect financial markets affect the real economy in Slovenia, as concluded by the analysis presented in Chapters Three and Four. Therefore, including the financial market in the macroeconometric model of Slovenia is crucial for ensuring the reliability of simulations. We included an extended block of investment financing costs and the income channel affecting Slovenian business and residential investment. With the counterfactual scenario, we quantify the contribution of the financial accelerator effect after the exogenous shocks. In the last chapter, we compare the effects of financial shocks on the

fiscal dynamics of euro area countries to discuss the heterogeneity of the observed effects and its sources.

In the second chapter of the dissertation, we provide a systematic overview of the research conducted in the research field of investigating the relationship between the financial and real economy. To achieve this, we employ a bibliometric methodology that allows us to objectively examine the evolution of the research field, considering its historical context. This methodology enables us to identify influential contributions, authors, and journals, providing valuable insights into the field's historical development and contextual factors. In addition to the comprehensive literature review, we conduct a content analysis of the most influential contributions regarding thematic analysis, data utilised, the methodology employed, and their key contributions to advancing knowledge in this field. Building upon this analysis, we address the following research questions:

- Research Question 2.1: How did the research field of the relationship between the financial and real economy develop throughout history?

  The investigated research field exhibited a gradual increase in scientific productivity in the early 1990s, although it remained relatively low until the Great Recession (2007–2009). The severe macroeconomic consequences resulting from this financial crisis notably intensified the scientific community's interest in comprehending the underlying interconnection between the financial and real economy. Our analysis has yielded several significant findings pertaining to the research field under examination. Firstly, it indicates that the most prolific authors, as determined by total citations, are Laeven L., Longstaff F. A., and Adrian T. Additionally, Gallegati M. and Kutan A. M. emerge as the most influential authors according to the H-index. Secondly, we have identified the American Economic Review as the most influential journal, with 24 publications, 5,129 total citations, and an average of 17.258 citations per year. Furthermore, The Journal of Banking & Finance has attained the highest number of total citations, achieving 6,727 citations, corresponding to 189 publications.

- Research Question 2.2: Which are the most influential contributions that have significantly determined the evolution of the observed research field?

  Based on the total citations, the most influential article is 'The twin crises: The causes of banking and balance-of-payments problems' by Kaminsky and Reinhart (1999). This paper examines the interconnections between banking and currency crises and their implications for contractionary and recessionary periods within the business cycles. It is followed by the contributions 'Income-distribution and macroeconomics' by Galor and Zeira (1993) and 'Answering the skeptics: Yes, standard volatility models do provide accurate forecasts' by Andersen and Bollerslev (1998). However, it is important to consider that older papers may have had more time to accumulate

citations. To account for this factor, the average citations per year become a relevant criterion. Applying the latter criterion, the most influential paper is 'Deciphering the liquidity and credit crunch 2007–2008' by Brunnermeier (2009), published in the Journal of Economic Perspectives, with an average of 102.364 citations annually. In this work, the author provides an in-depth analysis of the economic mechanisms and events that significantly contributed to the extensive outbreak of the Great Recession, whose origins lie in the imbalances and instabilities of the financial sector.

The third chapter investigates the balance sheet effects on the panel of Slovenian non-financial companies observed between 2006 and 2020. The sample was further cross-sectionally split into financially constrained (small) companies and financially unconstrained (large) companies. Furthermore, we analysed the data subject to low economic growth (from 2006 to 2012) and stable economic growth (from 2013 to 2020). Results indicate that investment-cash flow sensitivities exist and are robust to different model specifications and subsamples. Its presence is most pronounced for small companies during financial distress. Including the companies' debt rate in the model allows the investigation of the presence of an external financing channel (bank lending channel). In this case, results indicate that a cash flow shock significantly affects the debt rate only in the case of financially constrained companies during the period of financial distress. In this chapter, we address the following research questions:

- Research Question 3.1: Is there evidence of investment-cash flow sensitivities in a sample of Slovenian companies?

  The performed analysis shows the relation between a company's cash flow and investment activity. Utilising the methodology set forth by Gilchrist and Himmelberg (1995, 1998), the effects of cash flow shocks are clearly distinguished from the exogenous changes in the production function. Since the impacts of cash flow shocks on the marginal productivity of capital are insignificant, we may conclude that financial frictions cause deviation from the theoretically optimal amount of investment determined by the marginal productivity of capital. Over the entire sample of non-financial companies in Slovenia, the cash flow affects the investment activity, thus confirming the sensitivity of investment to changes in cash flow. Similar conclusions were shown by Gilchrist and Himmelberg (1995, 1998) for the case of the US and by Melander et al. (2017) for the case of Sweden. However, the general notion of investment-cash flow sensitivities has limited information regarding the availability of bank financing.

- Research Question 3.2: Do financial frictions in Slovenia come to an effect through the bank-lending channel?

With the methodology of Gilchrist and Himmelberg (1995, 1998), investment-cash flow sensitivity is a direct testament to financial frictions. In the case of Slovenia, the external financing market is underdeveloped, meaning that the bank lending channel primarily determines the availability of external financing. By including debt rate as an endogenous variable, we could observe its responses to a cash flow shock. A bank-lending transmission channel is not evident when analysing the entire time period and the cross-section sample. However, the transmission channel of financial frictions through bank lending is evident in the case of financially constrained companies (small companies) during financial distress.

– Research Question 3.3: What kind of differences can be detected in estimating the financial frictions' effects on the investment activity of Slovenian non-financial companies during various phases of the business cycle?

  Temporal differences during various business cycle phases were investigated by analysing subsamples. The sample has been split into two periods: the period from 2006 to 2012, characterised by the financial crisis and the consequent sovereign debt crisis, and the period from 2013 to 2020, which was, on average, characterised by solid economic growth. Balance sheet effects are considerably amplified between 2006 and 2012, showing that financial frictions are prevalent primarily during economic downturns, while the effects are muted during periods of economic growth. Consistent with the study of Črnigoj and Verbič (2014), the more pronounced and significant effects are recorded for the case of small companies. Between 2013 and 2020, small companies' investment-cash sensitivity remains present. However, the reaction of the debt rate to the cash flow shock is not statistically significant. It should be noted that the impact on the debt rate of financially unconstrained companies to a positive cash flow shock is negative, reflecting the aggregate decrease in debt levels during this period.

In the fourth chapter, the underlying shocks of credit demand and credit supply were studied. To address the question of existing theoretical drivers, we developed a comprehensive partial equilibrium theory of the credit market. The presented theoretical model reveals the potential relevance of the liquidity demand shocks that, together with investment demand shocks, underline the credit demand. In contrast, credit supply is underlined by the banks' profit function shocks and credit risk shocks. Propositions of the theoretical setting have been empirically investigated with the structural BVAR model for the case of Slovenia. The results of the performed analysis shed light on the following research questions:

– Research Question 4.1: Which underlying factors may significantly determine loan demand and supply in the Slovenian credit market?

We observe two sources of variation in loan demand from the theoretical model. We decompose them into investment demand shocks and liquidity demand shocks. Investment demand shocks may originate in the changes in the production function that increase the optimal level of investment. In contrast, liquidity demand originates in the changes of the financing curve. Almeida et al. (2011) showed that liquidity holdings positively affected the firms' revenues during the economic downturn. Credit supply shocks may originate in an increase in the bank's profit function, which leads to a simultaneous increase in the lending rate, lower expected profits, and lower levels of outstanding loans. As banks retract the loan expansion with more restrictive policies, the outstanding financial risk tends to be lower. Credit supply shocks can also be affected by the credit risk shocks caused by the increase in the non-linear relation between outstanding loans and financial risk. A higher level of risk leads banks to expect higher profits, elevating the lending rate and decreasing the outstanding level of loans. The empirical model shows that loan supply shocks were historically the main drivers of the loan quantity, while the demand side shocks explain most of the variation in the lending rate. These results suggest that the business loan demand is flat while the loan supply function is steep.

- Research Question 4.2: What are the main determinants of the business investment activity in Slovenia over the previous two decades?

  Forecast error variance decomposition analysis based on the estimated BVAR model shows that credit supply shocks explain a non-negligible share of business investment in Slovenia. Such results are consistent with those of Gambetti and Musso (2017), who investigated the contribution of credit supply shocks to economic activity in the euro area, the United Kingdom, and the United States. However, most variation in business investment can be attributed to demand factors, from which the liquidity demand shocks stand out as the most important component. The relative importance of liquidity demand shocks hints at the notion that business investment in Slovenia primarily follows an excess in liquidity. In contrast, the investment demand curve is, on average, relatively stable.

- Research Question 4.3: What are the main determinants of business investment during the financial crisis?

  The contribution of credit market shocks during the period of financial distress can be discussed based on the historical decomposition of business investment in Slovenia throughout the financial and sovereign debt crisis. We can see that business investment in Slovenia first experienced a substantial decline in 2008Q4/2009Q1, despite the beginning of the global financial crisis in 2007. The decline was initially driven by a strong negative investment demand shock, followed by credit risk shocks, liquidity demand shocks, and banks' profit function shocks. Supply-side shocks in the credit

market contributed a sizable part of the negative contribution to the business investment, consistent with the work of Gambetti and Musso (2017). However, the differentiation between the credit risk shocks and banks' profit function shocks is crucial in this assessment, pointing to the fact that the vulnerable banking sector could not provide financing conditions to firms still demanding investment funding. The second ECB bond purchase programme successfully untied the loan supply in late 2011 and early 2012, creating favourable financing conditions. However, putting the supply shocks aside, the demand for liquidity appears to be the main factor that squeezed out the business investment in that period.

The focus of the analysis in Chapter Five is to strengthen the financial aspect of the existing quarterly macroeconometric model of a small open economy of Slovenia by including the additional transmission channels through which financial frictions may affect the overall economy. The enhanced financial transmission channels contributed positively to the reactivity of macroeconomic variables on the financial shocks that increase the financing rates. The analysis has shown that financial frictions significantly affect the Slovenian economy's resilience through the pure macroeconomic perspective and the fiscal policy position. The performed analysis yields the opportunity to address the following research questions:

– Research Question 5.1: Which transmission channels are of key importance to efficiently model the effects of financial frictions in the Slovenian economy within the existing quarterly macroeconometric framework?

  The main transmission channels amplified by financial frictions are the lending rate and income channels. The lending rate channel is amplified with the separate modelling of the user cost of capital for residential and business investments. The other amplification channel stems from the relationship between income and investment. The analysis presented in Chapter Four shows that this relation is partially driven by different credit market shocks. Thus, only part of the relation can be attributed to investment demand factors, while other shocks are seen as a financial amplification mechanism.

– Research Question 5.2: How do the financial frictions affect the Slovenian economy, and through which macroeconomic aggregates are the influences most observant?

  Financial amplification affects the economy through the lending rate and income channels. Simulations of monetary policy shock, oil price shock, world demand shock, and exchange rate shock show that financial frictions magnify the effects of unexpected shocks on macroeconomic aggregates. The contributions of financial frictions are the most observant in the monetary policy shock effects as the effects are exacerbated by the interest rate and income channels. It should be noted that the impacts of financial

frictions are observed mainly in the responses of investment activity and consequent responses of the GDP, from which their effects spread further through the economy.

- Research Question 5.3: How do financial frictions affect the fiscal position of the Slovenian economy?

  Financial frictions contribute positively to the debt-to-GDP ratio in the case of adverse economic scenarios. The effect is the strongest in the case of the monetary policy shock due to stronger interaction with the financial markets. In the case of the oil price shock, the long-term impact on the government debt is even negative, as the higher inflation rate boosts the government revenues from tax increases and the nominal GDP. However, even in the case of an oil price shock, the scenario with the absence of financial frictions implies a more resilient fiscal stance. In the case of world demand shock and the effective exchange rate shock, the differences between the two scenarios are smaller, as the differences arise primarily from the investment activity, which only partially translates into the variables related to the fiscal position.

In the sixth chapter, the impacts of financial distress on fiscal dynamics are investigated. The analysis is focused on fiscal developments in the euro area countries during the Great Recession. The observed period was primarily defined by significant stock market declines, heightened systemic risks, and a notable rise in bank failures. The adverse conditions compelled governments to take decisive policy measures to maintain economic activity and prevent a complete collapse of the financial sector. In contrast to the previous financial crises, the attempts to stabilise the economy were not focused primarily on the responses of the automatic stabilisers, as the extent of the crisis required undertaking significant discretionary and interventionist government measures. Such fiscal interventions are vital for stabilising the economy during crises but can result in substantial fiscal costs. Hence, the main goal of the analysis is to provide some insights into the following research questions:

- Research Question 6.1: How does the fiscal position react to the financial shock across the euro area countries?

  Responses of fiscal dynamics to financial shocks in euro area countries are highly heterogeneous. Heterogeneous effects are evident in cases of government debt-to-GDP and the government bond yield spreads. The decomposition of financial shocks to the common and idiosyncratic shocks shows additional components of cross-country heterogeneity. In most countries, the idiosyncratic component importantly exacerbated the fiscal position. In the case of Greece, the idiosyncratic component contributed the majority of the debt-to-GDP ratio increase after the financial shock. In contrast, the Italian response can be almost exclusively attributed to the influence of common factors. The government bond yield reaction is similarly heterogeneous across

countries, as the two-year spread increase ranges from 0.22 p.p. in the case of Finland to 0.73 p.p. in Greece. The idiosyncratic financial shock is the main driver of cross-country heterogeneity of government bond yield spreads across the observed euro area countries.

– Research Question 6.2: What are the possible drivers of the heterogeneous responses of fiscal position to the financial distress in the euro area countries?

  The heterogeneity of changes in government debt-to-GDP can be explained primarily by the level of debt-to-GDP in the period antecedent to the financial shock. The reasons for heterogeneous responses of the government bond yield spreads are much more versatile. The larger country size, trade openness, and GDP per capita negatively affect government bond yields. At the same time, the relative importance of the financial sector and the debt-to-GDP ratio are significant positive contributors to the level of government bond yield.

7.2 Contribution

A doctoral dissertation has a widespread contribution to the research field of examining the effects of financial frictions on the real economy and fiscal dynamics. It provides a comprehensive literature overview with content analysis that allows one to be familiarised with the historical developments and current trends of the literature. Important issues regarding the underlying sources of credit market fluctuations have been discussed through the lens of theoretical models and empirical modelling. Empirically, financial frictions have been analysed using the micro panel of non-financial companies in Slovenia over an extended period. Furthermore, the underlying components of credit market shocks from the Bayesian VAR model have been uncovered using theoretically founded sign restrictions. Additional contributions pertain to the further development of the existing quarterly macroeconometric model by expanding the modelling of the financial sector and using a structural panel vector autoregressive (SPVAR) model to analyse the impact of financial shocks on fiscal dynamics.

A comprehensive literature review involves a search of keywords from a wide selection of relevant papers. The bibliometric study approach, based on a large metadata database, is crucial for achieving a high degree of objectivity. In addition to citation analysis, the most prolific and influential authors, journals, and articles in the field are systematically presented. Finally, the dissertation contributes to the literature through the detailed content analysis of the 50 most influential articles based on the average number of citations per year. The content analysis, in the sense of themes, methodology, data, and contributions, provides some prominent insights into the articles, which can be viewed as scientific breakthroughs in the research field of the relationship between the financial and real economy.

The third chapter analyses the large dataset of non-financial companies in Slovenia from 2006 to 2020. The analysis is based on estimating the panel VAR model that aims to uncover the presence of the financial accelerator effect. The analysis contributes to the literature by observing a relatively long period that includes a significant economic downturn in light of the global financial crisis, allowing us to assess the financing conditions during the economic downturn. Furthermore, compared to other studies, we analyse a set of small, financially constrained firms that allows us to draw conclusions regarding the duality of accessibility of external financing for large and small companies. Compared to Gilchrist and Himmelberg (1995) and Melander et al. (2017), we explicitly test for the presence of external financing frictions by extending the panel VAR model with the external debt ratio.

In Chapter Four, we contribute to theoretical literature by presenting the theoretical partial equilibrium model, where we examine the reasons for liquidity holdings, which may be the main driver of business investment variation. Furthermore, we extend the analysis to the estimation of the structural Bayesian VAR model. Introducing liquidity demand as a separate shock in the structural BVAR model is an innovation rooted in the imperfection of capital markets. In addition to the liquidity demand shock, we identify investment demand shock, credit risk shock, and banks' profit function shock. The latter two shocks constitute the credit supply, while the liquidity and investment demand shocks constitute the changes in the credit demand. To the best of our knowledge, this is the first study to decompose empirically the business investment variation into the underlying shocks that drive the credit market.

In Chapter Five, the macroeconometric model of the small open economy of Slovenia has been enhanced by additional equations to capture the amplification effects stemming from the financial markets. The equations of lending rates for residential and business investments were included in the model to better resemble the cost of investment financing. Furthermore, due to the different nature of investment decisions, we distinguished between business and residential investment to better capture the presence of income effects that amplify the effects of exogenous shocks on the macroeconomic activity.

Finally, we contributed to the literature on heterogeneity across euro area countries by revisiting the country-specific responses to a financial shock. Methodological contributions to the literature can be seen in combining the macroeconomic structural panel VAR model with the narrative-sign restriction identification. To the best of our knowledge, this is the first paper to combine these two approaches. Furthermore, we utilised the cross-section variation to empirically assess the reasons for cross-country heterogeneity.

7.3 Limitations and future research

The dissertation provides new methodological and theoretical approaches to modelling the effects of financial frictions on the real economy and fiscal dynamics. However, several limitations and unanswered questions still constitute the basis for future research in this field. The bibliometric analysis could, in principle, be extended to other sources of article metadata and consider other measures of the quality of publications apart from the number of citations, as it may inadequately represent the research quality due to self-citations and 'negative' citations. In Chapter Three, we show the presence of balance sheet effects on investment activity in Slovenia and that the external financing conditions only have a limited effect on investment activity. However, the panel VAR based on firm-level data does not account for the potential liquidity preferences of companies that could potentially uncover the underlying reason for the presence of investment-cash flow sensitivities. Additionally, complementary to the size of the companies, other determinants for identifying financially constrained companies, such as asset tangibility, profitability, and age of the companies, may be used for further robustness checks.

The theoretical partial equilibrium model presented in chapter Four assumes a uniform distribution of production shocks, which could, in principle, be extended to a more general case of the probability distribution function. Furthermore, one could relax the assumption of the independent distribution of production shocks as the negative shocks usually persist over several periods. In the empirical part, we show that liquidity demand shocks contribute significantly to the historical development of business investment. This notion raises the question of reasons for liquidity demand to prevail as a main factor. One could also address the presence of similar shocks in other countries.

The macroeconometric model for Slovenia could be further developed by explicit modelling of the banking sector and bank loans. The main reasons for such a decision are the possible discrepancies between the credit demand and investment activity and the deleveraging process of Slovenian non-financial companies and households in the aftermath of the sovereign debt crisis. However, our approach implicitly includes credit rationing, liquidity demand, and uncertainty channels through the income channel. Lastly, in the SPVAR model, we identify the financial shock with the narrative-sign restrictions on a limited number of variables. This limitation prevents us from clearly distinguishing the financial shock from the uncertainty shock and demand shock from the perspective of sign restrictions.

In addition to these acknowledged limitations, it would also be beneficial to consider the impact of changing economic structures and policy shifts in future studies. As economies and policies evolve, the context in which findings hold may undergo significant transformations. Factors like shifts in fiscal and monetary regulations, technological advancements, or geopolitical and environmental changes can influence the presented estimates. This could potentially affect the reliability of the current empirical conclusions

as new variables and intricate causal connections come into play. Moving forward, it is essential for future research to navigate these dynamic factors, connecting theoretical frameworks with real-world complexities, which may provide a more robust understanding of how financial frictions, real economy, and fiscal dynamics interact in a shifting environment.

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APPENDICES

Appendix 1: Daljši povzetek (Extended summary in Slovene language)

UČINKI FINANČNIH TRENJ NA REALNO GOSPODARSTVO IN FISKALNO DINAMIKO

Zadnji dve desetletji lahko spremljamo razpravo o posledicah finančnih trenj za različne ključne makroekonomske agregate, ki sestavljajo današnja svetovna gospodarstva. Ta trenja so lahko posledica asimetrije informacij med deležniki na finančnih trgih ali nepopolnosti znotraj finančnega sektorja. Nedavni trendi, ki smo jih lahko opazili v razvitih gospodarstvih, so razkrili močno soodvisnost med stabilnostjo finančnega sektorja in makroekonomskimi spremenljivkami. Očitno je, da je finančni sektor postal pomemben del gospodarstva, z razvojem države pa njegova naraščajoča kompleksnost in obseg ustvarjata številne kanale, prek katerih lahko ta sektor vpliva na uspešnost celotnega gospodarstva.

Po eni strani naj bi finančni sektor zagotavljal sredstva, ki spodbujajo potrošnjo in investicije gospodinjstev in nefinančnih podjetij ter tako predstavljal gonilo gospodarske rasti, po drugi strani pa lahko nestabilnosti na finančnem trgu povzročijo znatne makroekonomske posledice, kot smo lahko opazili tudi v času velike recesije (2007–2009).

Omenjeni gospodarski upad je obnovil zanimanje ekonomistov in oblikovalcev politik za razumevanje in ocenjevanje vpliva transmisijskih kanalov med finančnim in realnim gospodarstvom. Čeprav ti kanali na splošno delujejo v obe smeri, je bil prenos šokov iz realnih na finančne sektorje že priznan kot del standardne makroekonomske teorije. Zato so se ekonomisti, zlasti v zadnjih dveh desetletjih, osredotočili na ključne kanale, ki delujejo v nasprotni smeri. Teoretična literatura (Foglia in drugi, 2011) nakazuje obstoj treh splošnih skupin takšnih kanalov, ki vključujejo prenos šokov iz finančnih trgov v realno gospodarstvo ali okrepitev šokov, ki izvirajo iz realnega gospodarstva, zaradi dogajanja na finančnih trgih. To so: bilančni kanal posojilojemalca, bilančni kanal banke in kanal likvidnosti.

Bilančni kanal posojilojemalca se pojavi zaradi nezmožnosti finančnega sektorja, da natančno oceni kreditno sposobnost posojilojemalcev (gospodinjstev ali podjetij) in spremlja njihove investicijske aktivnosti. To vodi do prilagoditve premije za zunanje financiranje kot odziva na splošne makroekonomske razmere. Med gospodarskim krčenjem takšne prilagoditve stroškov zunanjega financiranja neposredno vplivajo na potrošnjo in investicijsko aktivnost, kar dodatno poslabša gospodarske razmere. Nasprotno se bilančni kanal banke pojavi, kadar so spremembe v zunanjem financiranju posojilojemalcev posledica neposrednih učinkov monetarne in regulativne politike na bilance stanja bank. Zadnji kanal, tj. kanal likvidnosti, lahko bodisi okrepi obstoječe transmisijske kanale bodisi povzroči nastanek dodatnih kanalov, do katerih pride zaradi sprememb likvidnosti v finančnih institucijah kot posledice ukrepov monetarne politike.

Poleg tega finančna trenja in njihove posledice pomembno vplivajo tudi na fiskalni položaj gospodarstev. Obdobje velike recesije so zaznamovali borzni zlomi, povečana sistemska tveganja in pogosto neizpolnjevanje kreditnih obveznosti. Vlade so bile prisiljene izvajati odločne ukrepe za ohranitev gospodarske aktivnosti in preprečitev propada finančnega sektorja. Takšni posegi so ključni za stabilizacijo gospodarstva po izbruhu gospodarske krize, vendar povzročijo znatne neposredne in posredne fiskalne stroške. Širše gledano gospodarski upad negativno vpliva na davčne prihodke in povečuje javnofinančne odhodke prek delovanja avtomatskih fiskalnih stabilizatorjev.

Poleg tega neposredni fiskalni stroški pomenijo dodatno obremenitev javnih financ zaradi diskrecijskih ukrepov vlade za preprečevanje nadaljnjih motenj gospodarske aktivnosti. Med nedavno finančno krizo so ti posegi pogosto vključevali ciljno usmerjene svežnje za stabilizacijo ranljivega finančnega sektorja, kot so kapitalske injekcije v bančni sektor, izplačila unovčenih jamstev, subvencije nefinančnim podjetjem in izplačila vlagateljem (Tagkalakis, 2013). Zato je potreba po fiskalnih spodbudah pri premagovanju finančnih kriz in ponovni vzpostavitvi finančne stabilnosti pogosto precejšnja in se odraža v znatnih primarnih primanjkljajih ter posledično znatnem povečanju javnega dolga.

Disertacijo sestavlja sedem poglavij. Poleg uvoda in zaključka vsebuje pet glavnih poglavij, ki obravnavajo specifično temo s širšega raziskovalnega področja preučevanja učinkov finančnih trenj na realno gospodarstvo in fiskalno dinamiko. V nadaljevanju je podan pregled namena, ciljev in glavnih raziskovalnih vprašanj, ločeno za vsako poglavje vsebinskega dela disertacije. Sledi povzetek ključnih znanstvenih prispevkov doktorske disertacije.

Namen drugega poglavja je s pomočjo bibliometrične metodologije zagotoviti sistematičen pregled raziskav s širšega področja preučevanja razmerij med finančnim in realnim gospodarstvom. Omenjena metodologija omogoča identifikacijo vplivnih prispevkov, avtorjev in revij ter vpogled v zgodovinski razvoj in kontekst. Obsežen pregled literature dopolnjuje vsebinska analiza najvplivnejših prispevkov s tega področja v smislu tematske analize, podatkov in metodologije, uporabljenih pri opazovanih analizah, ter njihovih ključnih prispevkov k razvoju znanja. Izvedeni analizi odgovarjata na naslednji raziskovalni vprašanji:

– Raziskovalno vprašanje 2.1: Kako se je skozi zgodovino razvijalo raziskovalno področje razmerja med finančnim in realnim gospodarstvom?

  Od začetka devetdesetih let prejšnjega stoletja se je znanstvena produktivnost na preučevanem raziskovalnem področju postopoma povečevala, čeprav je vse do velike recesije (2007–2009) ostala razmeroma nizka. Znatna makroekonomska nihanja, ki so bila posledica omenjene finančne krize, so okrepila zanimanje znanstvene skupnosti za razumevanje osnovne medsebojne povezanosti finančnega in realnega gospodarstva. Naša analiza je podala več pomembnih ugotovitev, ki se nanašajo na obravnavano

raziskovalno področje. Prvič, pokazala je, da so po skupnem številu citatov najproduktivnejši avtorji s tega področja Laeven L., Longstaff F. A. in Adrian T. Če se osredotočimo na rangiranje avtorjev po pripadajočem H-indeksu sta najvplivnejša avtorja Gallegati M. in Kutan A. M. Drugič, kot najvplivnejšo revijo smo opredelili American Economic Review s 24 objavami, 5.129 celotnimi citati in povprečjem17,258 citatov na leto. Revija The Journal of Banking & Finance je dosegla največje število skupnih citatov, in sicer 6.727 citatov na podlagi 189 publikacij.

– Raziskovalno vprašanje 2.2: Kateri so najvplivnejši prispevki, ki so pomembno vplivali na razvoj preučevanega raziskovalnega področja?

  Glede na skupno število citatov je najvplivnejši članek „The twin crises: The causes of banking and balance-of-payments problems" avtoric Kaminsky in Reinhart (1999). Članek obravnava medsebojne povezave med bančnimi in valutnimi krizami ter njihove posledice za obdobja krčenja in recesij znotraj poslovnih ciklov. Sledita prispevka „Income-distribution and macroeconomics", ki sta ga pripravila Galor in Zeira (1993), ter „Answering the skeptics: Yes, standard volatility models do provide accurate forecasts", ki sta ga predstavila Andersen in Bollerslev (1998). Vendar je treba pri tem upoštevati dejstvo, da so imeli starejši članki na voljo več časa za zbiranje citatov. Da nevtraliziramo vpliv tega dejavnika, smo kot merilo raje uporabili povprečno število citatov na leto. Na podlagi tega merila je najvplivnejši članek Brunnermeierja (2009): „Deciphering the liquidity and credit crunch 2007–2008", objavljen v reviji Journal of Economic Perspectives, ki ima povprečno 102,364 citatov na leto. V navedenem delu avtor poglobljeno analizira ekonomske mehanizme in dogodke, ki so pomembno prispevali k obsežnemu izbruhu velike recesije, katere izvor je v neravnovesju in nestabilnosti finančnega sektorja.

Tretje poglavje se osredotoča na specifično raziskovalno področje in je namenjeno preučevanju kanala bilance stanja posojilojemalcev v kontekstu slovenskih nefinančnih družb. Natančneje, cilj poglavja je izboljšati razumevanje vpliva nepopolnih finančnih trgov oziroma morebitnih finančnih omejitev na investicijsko dejavnost podjetij. Drugi cilji tega poglavja vključujejo opredelitev in analizo determinant podjetniških investicij, tako s temeljnega kot finančnega vidika. Poslovne investicije imajo v slovenskem gospodarstvu ključno vlogo, saj predstavljajo približno 11 % BDP (UMAR, 2023). Zaradi svoje izjemne volatilnosti in vpliva na poslovne cikle investicije v veliki meri določajo tudi dolgoročni razvoj gospodarstva. Raziskava bilančnega kanala posojilojemalcev podaja odgovor na naslednja raziskovalna vprašanja:

– Raziskovalno vprašanje 3.1: Ali na vzorcu slovenskih podjetij obstajajo dokazi o občutljivosti investicij na denarni tok?

Opravljena analiza kaže na povezanost denarnega toka podjetja in njegove investicijske aktivnosti. Z uporabo metodologije, ki sta jo predstavila Gilchrist in Himmelberg (1995, 1998), so učinki šokov v denarnem toku jasno ločeni od eksogenih sprememb v proizvodni funkciji. Ker so vplivi šokov v denarnem toku na mejno produktivnost kapitala neznačilni, lahko sklepamo, da finančna trenja povzročajo odstopanje od teoretično optimalnega obsega investicij, ki ga določa mejna produktivnost kapitala. Denarni tok vpliva na investicijsko aktivnost na celotnem vzorcu nefinančnih družb v Sloveniji, kar potrjuje občutljivost investicij na spremembe v denarnem toku. Podobne ugotovitve so pokazali Gilchrist in Himmelberg (1995, 1998) na primeru ZDA ter Melander in drugi (2017) na primeru Švedske. Vendar splošni pojem občutljivosti investicij na denarni tok upošteva zgolj omejene informacije glede razpoložljivosti bančnega financiranja.

- Raziskovalno vprašanje 3.2: Ali finančna trenja v Sloveniji učinkujejo prek kanala bančnih posojil?

  Skladno z metodologijo Gilchrista in Himmelberga (1995) je občutljivost investicij na denarni tok neposreden dokaz obstoja finančnih trenj. V Sloveniji je trg zunanjega financiranja razmeroma slabo razvit, kar pomeni, da razpoložljivost zunanjega financiranja primarno določa kanal bančnih posojil. Z vključitvijo posojil kot endogene spremenljivke smo lahko opazovali odzive kanala na šok v denarnem toku. V okviru analize celotnega časovnega obdobja in presečnega vzorca transmisijski kanal bančnih posojil ni očiten. Je pa očiten transmisijski kanal finančnih trenj prek bančnih posojil v primeru podjetij, ki se v času gospodarskega upada soočajo z omejenim dostopom do zunanjih virov financiranja.

- Raziskovalno vprašanje 3.3: Katere razlike je mogoče zaznati pri ocenjevanju učinkov finančnih trenj na investicijsko aktivnost slovenskih nefinančnih podjetij v različnih fazah poslovnega cikla?

  Razlike v vplivu finančnih trenj glede na različne faze poslovnega cikla smo raziskovali z analizo podvzorcev. Vzorec smo razdelili na dve obdobji, in sicer na obdobje od leta 2006 do leta 2012, ki sta ga zaznamovali finančna in posledična dolžniška kriza, ter na obdobje od leta 2013 do leta 2020, za katero je bila v povprečju značilna robustna gospodarska rast. Učinki bilanc stanja med letoma 2006 in 2012 so bili precej okrepljeni, kar kaže, da finančna trenja prevladujejo predvsem v obdobjih gospodarskega upada, medtem ko so njihovi učinki v obdobjih gospodarske rasti šibkejši. Skladno s študijo Črnigoja in Verbiča (2014) so izrazitejši in pomembnejši učinki zabeleženi v primeru opazovanja investicijske aktivnosti majhnih podjetij. Med letoma 2013 in 2020 je bila občutljivost investicij majhnih podjetij na denarni tok še vedno prisotna, vendar odziv stopnje zadolženosti na šok v denarnem toku ni bil statistično značilen. Omeniti moramo, da je vpliv na stopnjo dolga finančno

neomejenih podjetij na pozitivni šok v denarnem toka negativen, kar odraža skupno zmanjšanje ravni dolga v tem obdobju.

Namen četrtega poglavja je na podlagi rezultatov iz prejšnjega poglavja raziskati temeljne šoke na kreditnem trgu, ki so v preteklosti vplivali na poslovne investicije v Sloveniji. Poglavje presega obstoječo literaturo z raziskovanjem globljih strukturnih šokov, ki ustrezajo znanim šokom v povpraševanju in ponudbi kreditov. V ta namen poglavje predlaga teoretični model, ki predstavlja niz strukturnih enačb, nadalje empirično ovrednotenih z uporabo strukturnega Bayesianskega vektorskega avtoregresijskega (BVAR) modela. Cilj tega poglavja je pojasniti transmisijske kanale temeljnih šokov, ki vodijo do sprememb krivulj ponudbe posojil in povpraševanja po njih. Na podlagi eksplicitne teoretične predstavitve poskuša nadaljnja analiza v tem poglavju celovito pojasniti, kako ti šoki vplivajo na kreditni trg. Zato poglavje prispeva h globljemu razumevanju dinamike in gonilnih sil kreditnih trgov v obdobjih gospodarskega upada. Rezultati analize osvetljujejo naslednja raziskovalna vprašanja:

- Raziskovalno vprašanje 4.1: Kateri temeljni dejavniki lahko pomembno vplivajo na povpraševanje in ponudbo posojil na slovenskem kreditnem trgu?

  V teoretičnem modelu najdemo dva vira šokov v povpraševanju po posojilih ter jih lahko posledično razčlenimo na investicijske in likvidnostne povpraševalne šoke. Šoki v povpraševanju po investicijah lahko izvirajo iz sprememb v proizvodni funkciji, ki povečujejo optimalno raven investicij. Na drugi strani povpraševanje po likvidnosti izvira iz sprememb krivulje financiranja. Almeida in drugi (2011) so pokazali, da so likvidnostne rezerve pozitivno vplivale na prihodke podjetij med gospodarsko recesijo. Šok v ponudbi posojil lahko izvira iz povečanja profitne funkcije banke, kar vodi v hkratno povečanje posojilne obrestne mere, nižje pričakovane dobičke in nižje ravni neodplačanih posojil. Ker banke z restriktivnejšo politiko hitreje znižajo ponudbo posojil, je finančno tveganje glede neizpolnjevanja kreditnih obveznosti praviloma nižje. Na šok v ponudbi posojil lahko vplivajo tudi šoki kreditnega tveganja, ki so posledica povečanja nelinearnega razmerja med neodplačanimi posojili in finančnim tveganjem. Zaradi višje ravni tveganja banke pričakujejo višje dobičke, kar zvišuje posojilno obrestno mero in znižuje raven neodplačanih posojil. Empirični model kaže, da so bili šoki na strani ponudbe posojil v preteklosti glavni dejavnik v zvezi z obsegom odobrenih posojil, medtem ko šoki na strani povpraševanja pojasnjujejo večino variacije v posojilni obrestni meri. Ti rezultati kažejo, da je krivulja povpraševanja po posojilih za podjetja relativno horizontalna, medtem ko je funkcija ponudbe posojil strma.

- Raziskovalno vprašanje 4.2: Katere so bile glavne determinante podjetniške investicijske aktivnosti v Sloveniji v zadnjih dveh desetletjih?

Analiza dekompozicije ocenjene variance spremenljivk na podlagi ocenjenega BVAR modela kaže, da šoki v ponudbi kreditov pojasnjujejo nezanemarljiv delež poslovnih investicij v Sloveniji. Takšni rezultati so skladni z ugotovitvami Gambettija in Mussa (2017), ki sta preučevala prispevek šokov v kreditni ponudbi h gospodarski aktivnosti v evroobmočju, Združenem kraljestvu in Združenih državah Amerike. Večino razlik v variiranju poslovnih investicij lahko pripišemo dejavnikom povpraševanja, med katerimi kot najpomembnejša komponenta izstopajo šoki v povpraševanju po likvidnosti. Relativni pomen šokov v povpraševanju po likvidnosti vodi do domneve, da poslovne investicije v Sloveniji primarno sledijo presežku likvidnosti, medtem ko za krivuljo povpraševanja po investicijah velja nasprotno in je v povprečju razmeroma stabilna.

– Raziskovalno vprašanje 4.3: Katere so glavne determinante poslovnih investicij v času finančne krize?

  O prispevku šokov na kreditnem trgu v obdobju finančne krize lahko razpravljamo na podlagi zgodovinske dekompozicije poslovnih investicij v Sloveniji v času finančne in dolžniške krize. Vidimo lahko, da so poslovne investicije v Sloveniji doživele znaten upad v zadnjem četrtletju 2008 in prvem četrtletju 2009, kljub temu, da se je svetovna finančna kriza začela v letu 2007. Upad je bil sprva posledica močnega negativnega šoka v povpraševanju po investicijah, kateremu so sledili šoki v kreditnem tveganju, šoki v povpraševanju po likvidnosti in šoki v profitni funkciji bank. Šok na strani ponudbe na kreditnem trgu je predstavljal precejšen del negativnega prispevka k poslovnim investicijam, kar je skladno z ugotovitvami Gambettija in Mussa (2017). Vendar je pri tej oceni ključno razlikovanje med šoki kreditnega tveganja in šoki v profitni funkciji bank, kar kaže na dejstvo, da ranljiv bančni sektor ni zmogel zagotoviti ugodnih pogojev za financiranje podjetij, ki še vedno povprašujejo po virih financiranja za investicijsko aktivnost. Drugi program nakupa obveznic ECB je konec leta 2011 in v začetku leta 2012 uspešno povišal ponudbo posojil in ustvaril ugodne pogoje financiranja. Vendar se zdi, da je bil glavni dejavnik, ki je v tem obdobju izrinil poslovne investicije, povpraševanje po likvidnosti.

Peto poglavje, ki temelji na ugotovitvah prejšnjih dveh poglavij, širše preučuje vpliv finančnih trenj na realno gospodarstvo in, do neke mere, tudi na odziv fiskalne politike. Zato to poglavje obravnava implementacijo dodatnih transmisijskih kanalov med finančnim in realnim gospodarstvom v obstoječem makroekonometričnem modelu slovenskega majhnega odprtega gospodarstva. Ta pristop omogoča ocenjevanje preučevanih učinkov z vključitvijo dodatnih podatkov o poslovnih in stanovanjskih investicijah, posojilnih obrestnih merah in bruto poslovnem presežku podjetij. Poleg tega se analiza, predstavljena v tem poglavju, osredotoča na izvedbo analize nasprotnih dejstev in, v nadaljevanju, na primerjavo simulacijskih rezultatov modela z eksplicitno modeliranimi finančnimi trenji in rezultatov, pridobljenih iz modela z omejenimi vplivi

opazovanega transmisijskega mehanizma. Cilj poglavja je pridobiti boljši vpogled v pomen razširjenega modeliranja finančnega sektorja v makroekonometričnem okviru in izboljšati razumevanje njegovega vpliva na celotno gospodarstvo. Opisana analiza podaja odgovore na naslednja raziskovalna vprašanja:

- Raziskovalno vprašanje 5.1: Kateri transmisijski kanali so ključnega pomena za učinkovito modeliranje učinkov finančnih trenj v slovenskem gospodarstvu v obstoječem četrtletnem makroekonometričnem okviru?

  Glavna transmisijska kanala, ki ju finančna trenja okrepijo, sta kanal posojilne obrestne mere in dohodkovni kanal. Kanal posojilne obrestne mere se okrepi z ločenim modeliranjem uporabnikovih stroškov kapitala za stanovanjske in poslovne investicije. Okrepitev drugega kanala izhaja iz razmerja med dohodkom in investicijami. Analiza, predstavljena v četrtem poglavju, kaže, da to razmerje delno določajo različni šoki na kreditnem trgu. Tako lahko le del opazovanega razmerja pripišemo dejavnikom povpraševanja po investicijah, medtem ko druge šoke obravnavamo kot mehanizem finančne okrepitve.

- Raziskovalno vprašanje 5.2: Kako finančna trenja vplivajo na slovensko gospodarstvo in prek katerih makroekonomskih agregatov so vplivi najbolj opazni?

  Finančna okrepitev eksogenih šokov vpliva na gospodarstvo prek kanala posojilne obrestne mere in dohodkovnega kanala. Simulacije šoka monetarne politike, šoka v cenah nafte, šoka v svetovnem povpraševanju in šoka deviznega tečaja kažejo, da finančna trenja okrepijo učinke zunanjih šokov na makroekonomske agregate. Prispevek finančnih trenj je najbolj opazen pri učinkih šoka monetarne politike, saj je monetarna politika tesno povezana z dinamiko finančnih trgov. Omeniti moramo, da so učinki finančnih trenj opazni predvsem pri odzivu investicijske aktivnosti in posledično pri BDP, od koder se njihovi učinki širijo na celotno gospodarstvo.

- Raziskovalno vprašanje 5.3: Kako finančna trenja vplivajo na fiskalni položaj slovenskega gospodarstva?

  Finančna trenja v primeru neugodnih gospodarskih scenarijev pozitivno prispevajo k razmerju med dolgom in BDP. Zaradi močnejše interakcije s finančnimi trgi je učinek najmočnejši v primeru šoka monetarne politike. V primeru šoka v cenah nafte je dolgoročni učinek na javni dolg celo negativen, saj višja stopnja inflacije povečuje javnofinančne prihodke iz naslova povečanja davkov in nominalnega BDP. Vendar tudi v primeru šoka v cenah nafte scenarij z odsotnostjo finančnih trenj pomeni bolj odporno fiskalno naravnanost. V primeru šoka v svetovnem povpraševanju in šoka v efektivnem deviznem tečaju so razlike med scenarijema manjše, saj razlike izhajajo

predvsem iz investicijske aktivnosti, ki se le delno odraža v spremenljivkah, povezanih s fiskalnim položajem.

Šesto poglavje disertacije je namenjeno sistematični analizi vplivov finančnih šokov na fiskalno dinamiko evroobmočja, ki ga sestavlja 20 držav. Cilja poglavja sta torej dva. Prvič, analiza naj bi zagotovila celovit okvir za razumevanje vpliva finančnih šokov na spremenljivke, kot so razmerje med dolgom in BDP ter razlike v donosnosti državnih obveznic. Z drugimi besedami, analiza skuša razkriti kanale, prek katerih lahko finančna nestabilnost vpliva na javne finance, in osvetliti dinamiko javnega dolga ob pojavitvi finančnih šokov. Drugič, analiza se osredotoča na preučevanje heterogenosti med državami evroobmočja in njen vpliv na obseg dodatnih pritiskov na javne finance, ki izhajajo iz nestabilnosti in neravnovesij v finančnem sektorju. Glavni cilj analize je torej zagotoviti nekaj vpogledov v naslednji raziskovalni vprašanji:

- Raziskovalno vprašanje 6.1: Kako se fiskalni položaj odziva na finančni šok v državah evroobmočja?

  Odzivi fiskalne dinamike na finančne šoke v državah evroobmočja so zelo heterogeni. Heterogeni učinki se kažejo v primeru odziva razmerja med javnim dolgom in BDP ter odziva razponov donosnosti državnih obveznic. Razčlenitev finančnih šokov na skupne in idiosinkratične šoke pokaže dodatne komponente meddržavne heterogenosti. V večini držav je idiosinkratična komponenta pomembno poslabšala fiskalni položaj. V primeru Grčije je idiosinkratična komponenta prispevala celo večino k povečanju deleža dolga v BDP po finančnem šoku. Nasprotno lahko odziv Italije skoraj izključno pripišemo vplivu skupnih dejavnikov. Heterogenost lahko opazimo tudi v odzivu donosnosti državnih obveznic, saj se je ta v obdobju dvoletnega zamika povečala za od 0,22 odstotne točke v primeru Finske do 0,73 odstotne točke v primeru Grčije. Idiosinkratični finančni šok je bil glavni dejavnik pri heterogenosti odziva donosnosti državnih obveznic v državah evroobmočja.

- Raziskovalno vprašanje 6.2: Kateri so možni dejavniki heterogenih odzivov fiskalne dinamike na finančno krizo v državah evroobmočja?

  Heterogenost sprememb v razmerju med javnim dolgom in BDP lahko pojasnimo predvsem z ravnjo dolga v razmerju do BDP v obdobju pred finančnim pretresom. Razlogi za heterogene odzive razlik v donosnosti državnih obveznic so veliko bolj raznoliki. Večja velikost države, trgovinska odprtost in višji BDP na prebivalca negativno vplivajo na donosnost državnih obveznic. Hkrati relativni pomen finančnega sektorja ter razmerje med dolgom in BDP pomembno pozitivno vplivata na raven donosnosti državnih obveznic.

Doktorska disertacija pomembno prispeva k razvoju raziskovalnega področja preučevanja učinkov finančnih trenj na realno gospodarstvo in fiskalno dinamiko. Vsebuje obsežen

pregled literature z vsebinsko analizo, ki omogoča seznanitev z zgodovinskim razvojem in trenutnimi trendi. Pomembna vprašanja glede temeljnih virov nihanj na kreditnem trgu so obravnavana skozi prizmo teoretičnih modelov in empiričnega modeliranja. Empirično so bila finančna trenja analizirana na mikropanelu nefinančnih podjetij v Sloveniji, ki so bila spremljana skozi daljše obdobje. Poleg tega disertacija z uporabo teoretično utemeljenih omejitev predznaka in uporabo Bayesianskega VAR-modela razkriva osnovne komponente šokov na kreditnem trgu. Nadaljnji prispevki se nanašajo na nadaljnji razvoj četrtletnega makroekonometričnega modela z razširjeno vlogo finančnega sektorja in uporabo panelnega strukturnega VAR-modela za analizo vpliva finančnih šokov na fiskalno dinamiko.

Celovit pregled literature vključuje iskanje ključnih besed v širokem naboru ustreznih člankov. Pristop bibliometrične študije, ki temelji na obsežni zbirki podatkov, je ključen za doseganje visoke stopnje objektivnosti. Poleg analize citatov se v disertaciji sistematično predstavlja najproduktivnejše in najvplivnejše avtorje, revije in članke s preučevanega področja. Nadalje disertacija prispeva k literaturi s podrobno vsebinsko analizo 50 najvplivnejših člankov glede na povprečno število citatov na leto. Glede na obravnavane teme, uporabljeni metodologiji in podatke ter vidnejše prispevke vsebinska analiza ponuja nekaj pomembnih vpogledov v članke, ki jih lahko obravnavamo kot znanstvene preboje na raziskovalnem področju razmerja med finančnim in realnim gospodarstvom.

V tretjem poglavju smo analizirali obsežen nabor podatkov o nefinančnih podjetjih v Sloveniji med leti 2006 in 2020. Analiza temelji na ocenjevanju panelnega VAR-modela, namenjenega razkrivanju prisotnosti učinka finančnega pospeševalnika. Omenjena analiza prispeva k literaturi s preučevanjem razmeroma dolgega obdobja, ki vključuje pomemben gospodarski upad v času svetovne finančne krize, kar nam med drugim omogoča oceno pogojev financiranja v času gospodarskega upada. Poleg tega v primerjavi z drugimi študijami analiziramo skupino majhnih podjetij, ki se v večji meri soočajo s finančnimi omejitvami, kar nam omogoča oblikovanje sklepov o razlikah glede dostopa do zunanjega financiranja med velikimi in majhnimi podjetji. V primerjavi z Gilchristom in Himmelbergom (1995) ter Melanderjem in drugimi (2017) izrecno preverjamo prisotnost finančnih trenj z razširitvijo panelnega VAR-modela z deležem zunanjega dolga glede na celotna sredstva podjetij.

Četrto poglavje prispeva k teoretični literaturi s predstavitvijo teoretičnega modela, v katerem utemeljujemo razloge za povpraševanje po likvidnosti, ki je lahko glavno gonilo variabilnosti poslovnih investicij. Poleg tega smo analizo razširili na ocenjevanje strukturnega Bayesianskega VAR-modela. Uvedba povpraševanja po likvidnosti kot ločenega šoka v strukturnem BVAR-modelu je novost, ki odraža nepopolnost kapitalskih trgov. Poleg šoka v povpraševanju po likvidnosti preučujemo še šok v povpraševanju po investicijah, šok kreditnega tveganja in šok v profitni funkciji bank. Slednja vplivata na ponudbo kreditov, medtem ko šoka v likvidnostnem in investicijskem povpraševanju predstavljata spremembe v povpraševanju po kreditih. Po našem najboljšem vedenju je to

prva študija, ki empirično razčlenjuje spremembe poslovnih investicij na temeljne šoke, ki poganjajo kreditni trg.

Peto poglavje vsebuje analizo, v kateri smo obstoječi makroekonometrični model slovenskega majhnega odprtega gospodarstva nadgradili z dodatnimi enačbami, da vključimo dodatne učinke, ki izvirajo iz dinamike na finančnih trgih. V model smo vključili enačbe posojilnih obrestnih mer za stanovanjske in poslovne investicije, da bi bil bolj podoben modelu stroškov financiranja investicij. Poleg tega smo zaradi različne narave investicijskih odločitev razlikovali med poslovnimi in stanovanjskimi investicijami, da bolje zajamemo prisotnost dohodkovnih učinkov, ki okrepijo učinke eksogenih šokov na makroekonomsko aktivnost.

Nazadnje smo z disertacijo prispevali k literaturi o heterogenosti med državami evroobmočja s ponovnim pregledom odzivov posameznih držav na finančni šok. Metodološki prispevek k literaturi se kaže v kombinaciji makroekonomskega strukturnega panelnega VAR-modela z identifikacijo s predznakovnimi in pripovednimi omejitvami. Kot nam je znano, je to prva študija, ki združuje oba pristopa.

Appendix 2: Chapter 2 – 50 most influential articles

Table A1: List of the 50 most influential articles

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
1	Brunnermeier M. K.	Deciphering the liquidity and credit crunch 2007–2008	Journal of Economic Perspectives	2009	1,126	102.364	Financial crises	Detailed presentation of the Great Recession
2	Acharya V. V.; Pedersen L. H.; Philippon T.; Richardson M.	Measuring systemic risk	Review of Financial Studies	2017	242	80.667	Systemic risk	Proposing an intuitive way to measure each bank's contribution to systemic risk
3	Kaminsky G. L.; Reinhart C. M.	The twin crises: the causes of banking and balance-of-payments problems	American Economic Review	1999	1,346	64.095	Financial crises	Banking and currency crises are closely linked
4	Guesmi K.; Saadi S.; Abid I.; Ftiti Z.	Portfolio diversification with virtual currency: evidence from bitcoin	International Review of Financial Analysis	2019	59	59.000	Virtual currencies	Virtual currencies (Bitcoin) may offer diversification and hedging benefits for investors
5	Gulen H.; Ion M.	Policy uncertainty and corporate investment	Review of Financial Studies	2016	223	55.750	Corporate investment	A strong negative relationship between policy uncertainty and capital investments
6	Brunnermeier M. K.; Sannikov Y.	A macroeconomic model with a financial sector	American Economic Review	2014	334	55.667	Dynamics of the economy	Volatility paradox
7	Adrian T.; Shin H. S.	Liquidity and leverage	Journal of Financial Intermediation	2010	538	53.800	Financial market liquidity	Relationship between balance sheet size and leverage for security broker dealers

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
8	Arcand J. L.; Berkes E.; Panizza U.	Too much finance?	Journal of Economic Growth	2015	263	52.600	Finance-growth nexus	Relationship between financial depth and economic growth
9	Andersen T. G.; Bollerslev T.	Answering the skeptics: Yes, standard volatility models do provide accurate forecasts	International Economic Review	1998	1,142	51.909	Volatility in financial markets	Vastly improved ex-post volatility measurements
10	Berger A. N.; Udell G. F.	The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle	Journal of Banking & Finance	1998	1,120	50.909	Small business finance	Presentation of the roles of private equity and debt markets in the financial growth cycle
11	Christiano L. J.; Motto R.; Rostagno M.	Risk shocks	American Economic Review	2014	295	49.167	Measuring risk	Risk shock accounts for a large share of the fluctuations in macroeconomic variables
12	Galor O.; Zeira J.	Income-distribution and macroeconomics	Review of Economic Studies	1993	1,323	49.000	Income distribution	In the presence of credit markets' imperfections and indivisibilities in investment in human capital, the initial distribution of wealth affects macroeconomic variables

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
13	Gilchrist S.; Zakrajšek E.	Credit spreads and business cycle fluctuations	American Economic Review	2012	362	45.250	Credit spreads, Business cycle Fluctuations, Financial crises	The relationship between corporate bond credit spreads and economic activity, based on a new credit spread index
14	Bernanke B. S.; Gertler M.	Inside the black box: the credit channel of monetary policy transmission	Journal of Economic Perspectives	1995	1,085	43.400	Monetary policy transmission	Importance of the credit channel mechanism in the quantitatively successful analyses of monetary policy transmission
15	Alfaro L.; Chanda A.; Kalemli-Ozcan S.; Sayek S.	FDI and economic growth: the role of local financial markets	Journal of International Economics	2004	673	42.063	Effects of financial market conditions on FDI and economic growth	Positive causal link between FDI and growth through financial markets
16	Longstaff F. A.; Mithal S.; Neis E.	Corporate yield spreads: default risk or liquidity? New evidence from the credit default swap market	Journal of Finance	2005	617	41.133	Corporate yield spreads	The majority of the corporate spread is due to default risk
17	Jermann U.; Quadrini V.	Macroeconomic effects of financial shocks	American Economic Review	2012	328	41.000	Financial shocks	Tighter credit conditions have played an important role in all the recessions since the mid-1980s.
18	Bernanke B. S.; Blinder A. S.	The federal-funds rate and the channels of monetary transmission	American Economic Review	1992	1,120	40.000	Monetary policy transmission	Federal funds is extremely informative about future movements of real macroeconomic variables

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
19	Manova K.	Credit constraints, heterogeneous firms, and international trade	Review of Economic Studies	2013	273	39.000	Financial market imperfections	Well-functioning financial markets are thus necessary to support the global trade
20	King R. G.; Levine R.	Finance, entrepreneurship, and growth	Journal of Monetary Economics	1993	1,046	38.741	Importance of financial markets	A new mechanism by which financial systems influence long-run economic growth
21	Phillips P. C. B.; Wu Y. R.; Yu J.	Explosive behavior in the 1990s Nasdaq: When did exuberance escalate asset values?	International Economic Review	2011	325	36.111	Explosive behaviour in stock prices	A new approach to testing for explosive behaviour in stock prices
22	Bekaert G.; Ehrmann M.; Fratzscher M.; Mehl A.	The global crisis and equity market contagion	Journal of Finance	2014	215	35.833	Financial crisis	Understanding the global transmission channels of the crisis in equity markets
23	Collin-Dufresne P.; Goldstein R. S.; Martin J. S.	The determinants of credit spread changes	Journal of Finance	2001	659	34.684	Credit spreads	Investigation of the changes in credit spreads on individual bond yields
24	Klapper L.; Laeven L.; Rajan R.	Entry regulation as a barrier to entrepreneurship	Journal of Financial Economics	2006	481	34.357	Entrepreneurship, business environment, economic growth	Investigation of the impact of the business environment on entrepreneurship
25	Borio C.; Zhu H. B.	Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism?	Journal of Financial Stability	2012	249	31.125	Monetary policy transmission	Presentation of the risk-taking channel of monetary policy

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
26	Baruník J.; Křehlík T.	Measuring the frequency dynamics of financial connectedness and systemic risk	Journal of Financial Econometrics	2018	61	30.500	Measuring connectedness among financial variables, systemic risk	Contribution to the understanding of connectedness between economic variables by proposing to measure its frequency dynamics
27	Andersen T. G.; Bollerslev T.; Diebold F. X.; Vega C.	Real-time price discovery in global stock, bond and foreign exchange markets	Journal of International Economics	2007	387	29.769	Asset Pricing	Announcement surprises produce conditional mean jumps; hence high-frequency stock, bond and exchange rate dynamics are linked to fundamentals
28	Gertler M.; Karadi P.	Monetary policy surprises, credit costs, and economic activity	American Economic Journal: Macroeconomics	2015	144	28.800	Transmission of monetary policy	There is an enhanced movement in credit costs from the policy shock due to the response of term premia and credit costs
29	Noy I.	The macroeconomic consequences of disasters	Journal of Development Economics	2009	316	28.727	Natural disasters, macroeconomic consequences	Countries with better financial conditions position appear more robust and able to endure natural disasters with less spillover to GDP growth rates

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
30	Borio C.	The financial cycle and macroeconomics: What have we learnt?	Journal of Banking & Finance	2014	172	28.667	Financial cycles	Presentation of the stylised empirical features of the financial cycle, suggests modelling strategies, and considers its policy implications
31	Silvennoinen A.; Thorp S.	Financialization, crisis and commodity correlation dynamics	Journal of International Financial Markets Institutions & Money	2013	200	28.571	Financial integration	Increases in the VIX index are linked to higher commodity-stock correlation
32	Giuliano P.; Ruiz-Arranz M.	Remittances, financial development, and growth	Journal of Development Economics	2009	309	28.091	Financial development	Provides the first macroeconomic evidence of how remittances and financial development may interact in promoting growth
33	Zhang D. Y.; Lei L.; Ji Q.; Kutan A. M.	Economic policy uncertainty in the US and China and their impact on the global markets	Economic Modelling	2019	27	27.000	Economic policy uncertainty, connectedness	Although China has become more influential, the US's dominant position still holds in all the markets
34	Gerali A.; Neri S.; Sessa L.; Signoretti F. M.	Credit and banking in a DSGE model of the euro area	Journal of Money, Credit And Banking	2010	257	25.700	Financial frictions	Shocks originating in the banking sector explain the largest share of the contraction of economic activity in 2008

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
35	Karolyi G. A.; Lee K. H.; Van Dijk M. A.	Understanding commonality in liquidity around the world	Journal of Financial Economics	2012	205	25.625	Commonality in liquidity	Commonality in liquidity is greater in countries with and during times of high market volatility, greater presence of international investors, and more correlated trading activity
36	Gervais S.; Odean T.	Learning to be overconfident	Review of Financial Studies	2001	476	25.053	Overconfidence of traders	Demonstration that a simple and prevalent bias in evaluating one's own performance is sufficient to create market in which investors are, on average, overconfident
37	Arellano C.	Default risk and income fluctuations in emerging economies	American Economic Review	2008	297	24.750	Default risk	Modelling of endogenous default risk in a stochastic dynamic framework
38	Engle R. F.; Rangel J. G.	The spline-GARCH model for low-frequency volatility and its global macroeconomic causes	Review of Financial Studies	2008	295	24.583	Equity volatility	A new model to characterise the long-term pattern of market volatility in terms of its low-frequency component

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
39	Duffie D.; Saita L.; Wang K.	Multi-period corporate default prediction with stochastic covariates	Journal of Financial Economics	2007	317	24.385	Predicting corporate default	An econometric method for estimating term structures of corporate default probabilities
40	Frankel J. A.; Rose A. K.	Currency crashes in emerging markets: an empirical treatment	Journal of International Economics	1996	564	23.500	Currency crises	Crashes tend to occur when: output growth is low; the growth of domestic credit is high; and the level of foreign interest rates are high
41	Campbell J. Y.; Taksler G. B.	Equity volatility and corporate bond yields	Journal of Finance	2003	399	23.471	Equity volatility, corporate bond yields	A link between rising idiosyncratic equity risk and increasing yields on corporate bonds
42	Levine R.	Bank-based or market-based financial systems: Which is better?	Journal of Financial Intermediation	2002	422	23.444	Financial systems	Although overall financial development is robustly linked with economic growth, there is no support for either the bank-based or the market-based view
43	Pan J.; Singleton K. J.	Default and recovery implicit in the term structure of sovereign CDS spreads	Journal of Finance	2008	281	23.417	Term Structure of Sovereign CDS Spreads	The effects of risk premiums on CDS spreads co-vary strongly across countries

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
44	Galor O.; Moav O.	From physical to human capital accumulation: inequality and the process of development	Review of Economic Studies	2004	373	23.313	Growth theory	The growth theory unifies two fundamental approaches regarding the effect of income distribution on the process of development: the classical approach and the credit market Imperfection approach
45	Maghyereh A. I.; Awartani B.; Bouri E.	The directional volatility connectedness between crude oil and equity markets: new evidence from implied volatility indexes	Energy Economics	2016	91	22.750	Connectedness between markets	The majority of the observed relationships between oil and equity market are established in the period of global recovery (2009–2012)
46	Caiani A.; Godin A.; Caverzasi E.; Gallegati M.; Kinsella S.; Stiglitz J. E.	Agent based-stock flow consistent macroeconomics: towards a benchmark model	Journal of Economic Dynamics & Control	2016	89	22.250	Modelling of the economy	Presentation of a fully-decentralised agent based and stock flow consistent model with several innovative features
47	Guiso L.; Sapienza P.; Zingales L.	Does local financial development matter?	Quarterly Journal of Economics	2004	353	22.063	Financial development	Local financial development plays an important role even in a perfectly integrated market

To be continued

Table A1: List of the 50 most influential articles (cont.)

Rank	Authors	Title	Journal	Year	TC	ACY	Theme	Key contribution
48	Ouyang Y. F.; Li P.	On the nexus of financial development, economic growth, and energy consumption in China: new perspective from a GMM panel VAR approach	Energy Economics	2018	44	22.000	Financial development and economic growth	Financial development plays a negative role in both economic growth and energy consumption in China
49	Baumeister C.; Kilian L.	Forty years of oil price fluctuations: why the price of oil may still surprise us	Journal of Economic Perspectives	2016	86	21.500	Oil price fluctuations	Oil price shocks affect economic decisions, therefore, their understanding and the ability to predict them is also important for the policymakers and financial market participants
50	Jorda O.; Schularick M.; Taylor A. M.	The great mortgaging: housing finance, crises and business cycles	Economic Policy	2016	85	21.250	Housing finance	Provides new important insights into long-run credit dynamics in advanced economies

Note: TC – total citations, ACY – average citations per year.

Source: Own work.

Appendix 3: Chapter 3 – Stationarity

Table A2: Results of the Fisher-type unit-root tests for investment rate

Test statistic	Value	p-value
Inverse chi-squared(1,718)	3,090.704	0.000
Inverse normal	-11.305	0.000
Inverse logit t(3,224)	-20.337	0.000
Modified inv. chi-squared	23.418	0.000
Ho: All panels contain unit roots		
Ha: At least one panel is stationary		

Sources: AJPES, own work.

Table A3: Results of the Fisher-type unit-root tests for debt rate

Test statistic	Value	p-value
Inverse chi-squared(1,718)	2,884.960	0.000
Inverse normal	-11.864	0.000
Inverse logit t(3,224)	-19.288	0.000
Modified inv. chi-squared	19.908	0.000
Ho: All panels contain unit roots		
Ha: At least one panel is stationary		

Sources: AJPES, own work.

Table A4: Results of the Fisher-type unit-root tests for long-term debt rate

Test statistic	Value	p-value
Inverse chi-squared(1,718)	2,864.122	0.000
Inverse normal	-12.464	0.000
Inverse logit t(3,204)	-19.431	0.000
Modified inv. chi-squared	19.553	0.000
Ho: All panels contain unit roots		
Ha: At least one panel is stationary		

Sources: AJPES, own work.

Table A5: Results of the Fisher-type unit-root tests for marginal productivity of capital

Test statistic	Value	p-value
Inverse chi-squared(1,718)	2,566.498	0.000
Inverse normal	-0.747	0.227
Inverse logit t(3,224)	-7.922	0.000
Modified inv. chi-squared	14.475	0.000
Ho: All panels contain unit roots		
Ha: At least one panel is stationary		

Sources: AJPES, own work.

Table A6: Results of the Fisher-type unit-root tests for cash flow rate

Test statistic	Value	p-value
Inverse chi-squared(1,718)	2,445.377	0.000
Inverse normal	-2.568	0.005
Inverse logit t(3,209)	-9.158	0.000
Modified inv. chi-squared	12.409	0.000
Ho: All panels contain unit roots		
Ha: At least one panel is stationary		

Sources: AJPES, own work.

Table A7: Results of the Im-Pesaran-Shin unit-root test

Variable	W-t-bar test statistic	p-value
I	-39.918	0.000
D_tot	-36.088	0.000
D_lr	-41.958	0.000
MPK	-12.568	0.000
CF	-14.003	0.000
Ho: All panels contain unit roots		
Ha: Some panels are stationary		

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), D_lr – long-term debt rate (long-term debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio).

Sources: AJPES, own work.

Appendix 4: Chapter 3 – Estimation results

Table A8: Estimated coefficients for all companies

	I	D_tot	MPK	CF
lag1_I	-0.0874***	-0.0038	-0.0384***	-0.1326***
	(0.0250)	(0.0338)	(0.0052)	(0.0300)
lag1_D_tot	0.0778**	0.0276	0.0044	0.0331
	(0.0245)	(0.0395)	(0.0028)	(0.0247)
lag1_MPK	0.6752***	0.6060**	0.4106***	0.2749
	(0.1781)	(0.1957)	(0.0589)	(0.1914)
lag1_CF	0.1736***	0.0249	0.0103	0.4136***
	(0.0380)	(0.0429)	(0.0055)	(0.0565)

*** p < 0.001; ** p < 0.01; * p < 0.05

Number of observations: 11,859

Number of groups: 2,426

Hansen test: chi2(192) = 217.42 Prob > chi2 = 0.101

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A9: Eigenvalue stability condition for all companies

	Eigenvalue	Modulus
1	0.35558495+0.0233256i	0.35634919
2	0.35558495-0.0233256i	0.35634919
3	0.09400466+0.0000000i	0.09400466
4	-0.04088538+0.0000000i	0.04088538

Sources: AJPES, own work.

Table A10: Andrews-Lu criteria for all companies

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-2,062.122	-268.577	-924.970
2	-1,979.513	-281.439	-909.019
3	-1,874.905	-269.966	-869.063

Sources: AJPES, own work.

Table A11: Estimated coefficients for large companies

	I	D_tot	MPK	CF
lag1_I	0.0938**	0.0762	-0.0240**	-0.0963**
	(0.0337)	(0.0419)	(0.0074)	(0.0338)
lag1_D_tot	0.0035	0.0441	-0.0005	-0.0270
	(0.0302)	(0.0370)	(0.0049)	(0.0274)
lag1_MPK	0.1675	0.1740	0.2140*	0.2791
	(0.1415)	(0.2024)	(0.0947)	(0.1670)
lag1_CF	0.0812	0.0342	0.0234	0.4780***
	(0.0913)	(0.0977)	(0.0137)	(0.0993)
*** p < 0.001; ** p < 0.01; * p < 0.05				
Number of observations: 3,221				
Number of groups: 441				
Hansen test: chi2(192) = 211.59 Prob > chi2 = 0.158				

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A12: Eigenvalue stability condition for large companies

	Eigenvalue	Modulus
1	0.46891100+0.0000000i	0.46891100
2	0.16226117+0.0224135i	0.16380187
3	0.16226117-0.0224135i	0.16380187
4	0.03639629+0.0000000i	0.03639629

Sources: AJPES, own work.

Table A13: Andrews-Lu criteria for large companies

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,751.234	-274.414	-854.469
2	-1,688.293	-288.594	-842.867
3	-1,600.279	-276.685	-805.271

Sources: AJPES, own work.

Table A14: Estimated coefficients for small companies

	I	D_tot	MPK	CF
lag1_I	-0.1020***	-0.0097	-0.0411***	-0.1353***
	(0.0281)	(0.0383)	(0.0059)	(0.0343)
lag1_D_tot	0.0770**	0.0208	0.0042	0.0367
	(0.0266)	(0.0436)	(0.0030)	(0.0267)
lag1_MPK	0.7833***	0.6665**	0.4383***	0.2850
	(0.2081)	(0.2292)	(0.0654)	(0.2307)
lag1_CF	0.1625***	0.0294	0.0078	0.3962***
	(0.0391)	(0.0450)	(0.0055)	(0.0586)

*** p < 0.001; ** p < 0.01; * p < 0.05

Number of observations: 8,638

Number of groups: 1,985

Hansen test: chi2(192) = 204.25 Prob > chi2 = 0.259

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A15: Eigenvalue stability condition for small companies

	Eigenvalue	Modulus
1	0.35621734+0.0271732i	0.35725226
2	0.35621734-0.0271732i	0.35725226
3	0.08811357+0.0000000i	0.08811357
4	-0.04724962+0.0000000i	0.04724962

Sources: AJPES, own work.

Table A16: Andrews-Lu criteria for small companies

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,998.287	-281.753	-920.608
2	-1,909.326	-289.580	-898.940
3	-1,805.014	-279.379	-859.625

Sources: AJPES, own work.

Table A17: Estimated coefficients for large companies (2006–2012)

	I	D_tot	MPK	CF
lag1_I	0.1060*	0.0304	-0.0353**	-0.1345*
	(0.0448)	(0.0677)	(0.0116)	(0.0664)
lag1_D_tot	0.0259	0.0607	0.0081	0.0092
	(0.0364)	(0.0467)	(0.0052)	(0.0298)
lag1_MPK	-0.4503	0.7187	0.6018***	0.3639
	(0.5510)	(0.7510)	(0.1269)	(0.7074)
lag1_CF	0.1787*	0.2003	0.0159	0.5037**
	(0.0842)	(0.1695)	(0.0155)	(0.1605)
*** p < 0.001; ** p < 0.01; * p < 0.05				
Number of observations: 1,348				
Number of groups: 410				
Hansen test: chi2(64) = 65.99 Prob > chi2 = 0.408				

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A18: Eigenvalue stability condition for large companies (2006–2012)

	Eigenvalue	Modulus
1	0.65496075	0.65496075
2	0.42941429	0.42941429
3	0.17163922	0.17163922
4	0.01623284	0.01623284

Sources: AJPES, own work.

Table A19: Andrews-Lu criteria for large companies (2006–2012)

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-589.791	-116.010	-311.426
2	-526.481	-114.062	-287.031
3	-472.883	-122.891	-272.686

Sources: AJPES, own work.

Table A20: Estimated coefficients for small companies (2006–2012)

	I	D_tot	MPK	CF
lag1_I	-0.1080***	-0.0785	-0.0306***	-0.0903*
	(0.0319)	(0.0426)	(0.0063)	(0.0378)
lag1_D_tot	0.0889**	0.0742	0.0066*	0.0687
	(0.0327)	(0.0472)	(0.0028)	(0.0368)
lag1_MPK	0.7633*	1.1313*	0.3383***	0.0560
	(0.3027)	(0.4584)	(0.0842)	(0.3754)
lag1_CF	0.2169***	0.1655	0.0101	0.3516***
	(0.0609)	(0.1000)	(0.0085)	(0.0918)
*** p < 0.001; ** p < 0.01; * p < 0.05				
Number of observations: 3,171				
Number of groups: 1,309				
Hansen test: chi2(64) = 59.03 Prob > chi2 = 0.653				

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A21: Eigenvalue stability condition for small companies (2006–2012)

	Eigenvalue	Modulus
1	0.31415115	0.31415115
2	0.29819150	0.29819150
3	0.07461988	0.07461988
4	-0.03088918	0.03088918

Sources: AJPES, own work.

Table A22: Andrews-Lu criteria for small companies (2006–2012)

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-674.598	-122.974	-339.826
2	-605.063	-124.768	-317.247
3	-544.342	-135.533	-303.176

Sources: AJPES, own work.

Table A23: Estimated coefficients for large companies (2013–2020)

	I	D_tot	MPK	CF
lag1_I	0.1087	0.1448	-0.0068	-0.1979*
	(0.0691)	(0.0820)	(0.0104)	(0.0985)
lag1_D_tot	-0.0110	0.0263	-0.0125	-0.0017
	(0.0596)	(0.0800)	(0.0089)	(0.0490)
lag1_MPK	0.1878	-0.0398	0.0053	0.2595
	(0.1700)	(0.2559)	(0.0654)	(0.2209)
lag1_CF	0.0424	-0.3035*	0.0128	0.5356*
	(0.1917)	(0.1263)	(0.0194)	(0.2578)
*** p < 0.001; ** p < 0.01; * p < 0.05				
Number of observations: 1,386				
Number of groups: 338				
Hansen test: chi2(80) = 116.68 Prob > chi2 = 0.005				

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A24: Eigenvalue stability condition for large companies (2013–2020)

	Eigenvalue	Modulus
1	0.51931779+0.00000000i	0.51931779
2	0.12948604+0.00000000i	0.12948604
3	0.01350194+0.02571195i	0.02904147
4	0.01350194-0.02571195i	0.02904147

Sources: AJPES, own work.

Table A25: Andrews-Lu criteria for large companies (2013–2020)

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-679.083	-103.323	-340.430
2	-625.921	-111.263	-326.061
3	-576.151	-122.778	-314.923

Sources: AJPES, own work.

Table A26: Estimated coefficients for small companies (2013–2020)

	I	D_tot	MPK	CF
lag1_I	-0.1300**	0.0218	-0.0401***	-0.1686*
	(0.0459)	(0.0592)	(0.0094)	(0.0750)
lag1_D_tot	0.0629	-0.0611	-0.0019	-0.0228
	(0.0483)	(0.0625)	(0.0058)	(0.0615)
lag1_MPK	1.0179***	0.8004**	0.4028***	0.2646
	(0.2839)	(0.2836)	(0.0880)	(0.3254)
lag1_CF	0.2074**	0.0094	0.0160	0.5335***
	(0.0655)	(0.0842)	(0.0090)	(0.1279)
*** p < 0.001; ** p < 0.01; * p < 0.05				
Number of observations: 4,243				
Number of groups: 1,519				
Hansen test: chi2(80) = 88.23 Prob > chi2 = 0.248				

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A27: Eigenvalue stability condition for small companies (2013–2020)

	Eigenvalue	Modulus
1	0.4731045	0.4731045
2	0.2709743	0.2709743
3	0.1157302	0.1157302
4	-0.1146298	0.1146298

Sources: AJPES, own work.

Table A28: Andrews-Lu criteria for small companies (2013–2020)

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-830.603	-131.770	-402.096
2	-750.642	-126.765	-372.085
3	-681.905	-132.230	-352.414

Sources: AJPES, own work.

Appendix 5: Chapter 3 – Robustness checks

Table A29: Summary statistics of the variables included in the analysis with additional sectors

Sample	Variable	Mean	Std. deviation	Percentiles			Firm-year observations	Number of companies	Average number of employees
				25th	Median	75th			
All companies	I	0.36	0.91	0.04	0.13	0.35	42,834	6,708	94.38
	D_tot	0.17	1.23	-0.10	0.00	0.16			
	MPK	0.22	0.21	0.11	0.17	0.27			
	CF	0.56	1.51	0.13	0.27	0.53			
Big companies	I	0.25	0.61	0.05	0.12	0.27	7,651	788	361.28
	D_tot	0.08	0.65	-0.09	0.00	0.12			
	MPK	0.19	0.17	0.11	0.15	0.22			
	CF	0.36	0.60	0.11	0.22	0.40			
Small companies	I	0.38	0.96	0.03	0.13	0.37	35,183	5,920	36.34
	D_tot	0.19	1.32	-0.11	0.00	0.17			
	MPK	0.23	0.22	0.11	0.17	0.29			
	CF	0.61	1.64	0.14	0.28	0.56			

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio).

Sources: AJPES, own work.

Table A30: Summary statistics of the variables with long-term debt

Sample	Variable	Mean	Std. deviation	Percentiles			Firm-year observations	Number of companies	Average number of employees
				25th	Median	75th			
All companies	I	0.29	0.64	0.04	0.12	0.30	17,474	2,426	117.26
	D_lr	0.06	0.45	-0.08	0.11	0.05			
	MPK	0.14	0.14	0.11	0.16	0.24			
	CF	0.81	0.81	0.14	0.25	0.45			
Big companies	I	0.20	0.29	0.05	0.12	0.26	4,350	441	351.77
	D_lr	0.02	0.24	-0.15	-0.07	0.00			
	MPK	0.18	0.10	0.12	0.16	0.20			
	CF	0.31	0.42	0.13	0.23	0.38			
Small companies	I	0.32	0.72	0.03	0.12	0.32	13,124	1,985	39.53
	D_lr	0.08	0.5	-0.08	0.00	0.05			
	MPK	0.20	0.15	0.11	0.16	0.25			
	CF	0.44	0.90	0.14	0.26	0.48			

Note: I – investment rate (investment to capital ratio), D_lr – long-term debt rate (long-term debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio).

Sources: AJPES, own work.

Table A31: Estimated coefficients for large companies and alternative ordering

	D_tot	I	MPK	CF
lag1_D_tot	0.0441	0.0035	-0.0005	-0.0270
	(0.0370)	(0.0302)	(0.0049)	(0.0274)
lag1_I	0.0762	0.0938**	-0.0240**	-0.0963**
	(0.0419)	(0.0337)	(0.0074)	(0.0338)
lag1_MPK	0.1740	0.1675	0.2140*	0.2791
	(0.2024)	(0.1415)	(0.0947)	(0.1670)
lag1_CF	0.0342	0.0812	0.0234	0.4780***
	(0.0977)	(0.0913)	(0.0137)	(0.0993)

*** p < 0.001; ** p < 0.01; * p < 0.05

Number of observations: 3,221

Number of groups: 441

Hansen test: chi2(192) = 211.59 Prob > chi2 = 0.158

Note: D_tot – debt rate (total debt to capital ratio), I – investment rate (investment to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A32: Eigenvalue stability condition for large companies and alternative ordering

	Eigenvalue	Modulus
1	0.46891100+0.0000000i	0.46891100
2	0.16226117+0.0224135i	0.16380187
3	0.16226117-0.0224135i	0.16380187
4	0.03639629+0.0000000i	0.03639629

Sources: AJPES, own work.

Table A33: Andrews-Lu criteria for large companies and alternative ordering

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,751.234	-274.414	-854.470
2	-1,688.293	-288.594	-842.868
3	-1,600.279	-276.685	-805.272

Sources: AJPES, own work.

Table A34: Estimated coefficients for small companies and alternative ordering

	D_tot	I	MPK	CF
lag1_D_tot	0.0208	0.0770**	0.0042	0.0367
	(0.0436)	(0.0266)	(0.0030)	(0.0267)
lag1_I	-0.0097	-0.1020***	-0.0411***	-0.1353***
	(0.0383)	(0.0281)	(0.0059)	(0.0343)
lag1_MPK	0.6665**	0.7833***	0.4383***	0.2850
	(0.2292)	(0.2081)	(0.0654)	(0.2307)
lag1_CF	0.0294	0.1625***	0.0078	0.3962***
	(0.0450)	(0.0391)	(0.0055)	(0.0586)

*** p < 0.001; ** p < 0.01; * p < 0.05

Number of observations: 8,638

Number of groups: 1,985

Hansen test: chi2(192) = 204.25 Prob > chi2 = 0.259

Note: D_tot – debt rate (total debt to capital ratio), I – investment rate (investment to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A35: Eigenvalue stability condition for small companies and alternative ordering

	Eigenvalue	Modulus
1	0.35621734+0.0271732i	0.35725226
2	0.35621734-0.0271732i	0.35725226
3	0.08811357+0.0000000i	0.08811357
4	-0.04724962+0.0000000i	0.04724962

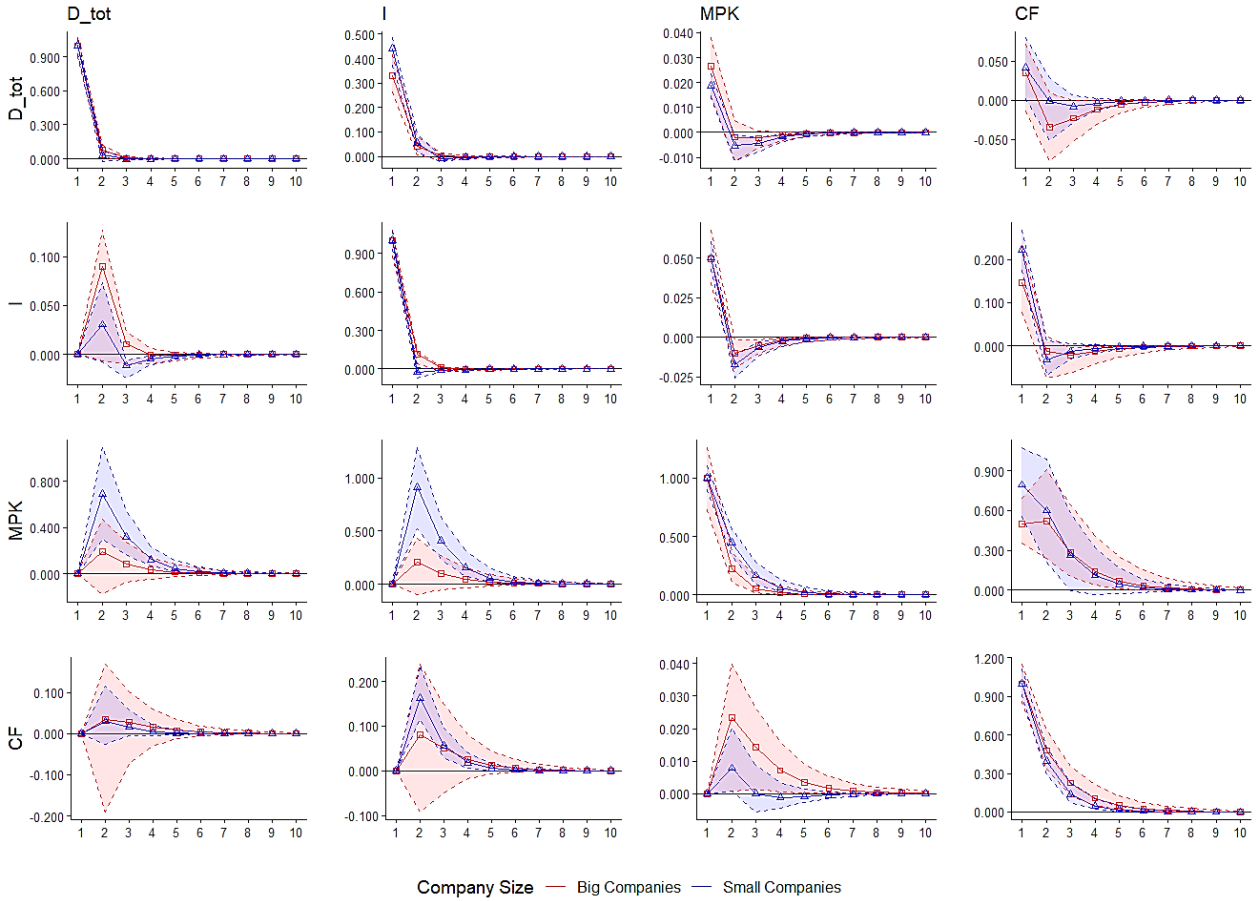
Sources: AJPES, own work.

Table A36: Andrews-Lu criteria for small companies and alternative ordering

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,998.287	-281.753	-920.608
2	-1,909.326	-289.580	-898.940
3	-1,805.014	-279.379	-859.625

Sources: AJPES, own work.

Figure A1: Impulse responses for the estimation with alternative ordering



Note: D_tot – debt rate (total debt-to-capital ratio), I – investment rate (investment-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws.

Sources: AJPES, own work.

Table A37: Estimated coefficients for large companies with two lags

	I	D_tot	MPK	CF
lag1_I	0.0189	0.0646	-0.0366***	-0.0899
	(0.0410)	(0.0456)	(0.0105)	(0.0527)
lag1_D_tot	0.0477	0.0615	0.0015	-0.0099
	(0.0319)	(0.0406)	(0.0057)	(0.0278)
lag1_MPK	0.6997**	0.2847	0.3070	0.5714*
	(0.2255)	(0.3347)	(0.1629)	(0.2834)
lag1_CF	0.0830	-0.1280	0.0224	0.3953*
	(0.1144)	(0.0734)	(0.0162)	(0.1774)
lag2_I	-0.0239	-0.0140	-0.0149*	0.0123
	(0.0230)	(0.0284)	(0.0059)	(0.0250)
lag2_D_tot	0.0047	-0.0225	0.0030	-0.0191
	(0.0178)	(0.0334)	(0.0040)	(0.0263)
lag2_MPK	0.3731**	0.1378	0.1005	0.2803
	(0.1213)	(0.1608)	(0.0673)	(0.1668)
lag2_CF	0.0737	0.0218	0.0019	-0.0232
	(0.0394)	(0.0425)	(0.0074)	(0.0598)

*** p < 0.001; ** p < 0.01; * p < 0.05

Number of observations: 2,782

Number of groups: 441

Hansen test: chi2(176) = 183.41 Prob > chi2 = 0.336

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A38: Eigenvalue stability condition for large companies with two lags

	Eigenvalue	Modulus
1	0.4219281+0.1392632i	0.4443169
2	0.4219281-0.1392632i	0.4443169
3	0.0210580+0.2005118i	0.2016145
4	0.0210580-0.2005118i	0.2016145
5	-0.1819501+0.0741201i	0.1964679
6	-0.1819501-0.0741201i	0.1964679
7	0.1303498+0.1441152i	0.1943200
8	0.1303498-0.1441152i	0.1943200

Sources: AJPES, own work.

Table A39: Andrews-Lu criteria for large companies with two lags

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,751.234	-274.414	-854.470
2	-1,688.293	-288.594	-842.868
3	-1,600.279	-276.685	-805.271

Sources: AJPES, own work.

Table A40: Estimated coefficients for small companies with two lags

	I	D_tot	MPK	CF
lag1_I	-0.1086***	0.0454	-0.0517***	-0.1078*
	(0.0301)	(0.0431)	(0.0087)	(0.0461)
lag1_D_tot	0.0405	-0.0296	0.0001	-0.0023
	(0.0220)	(0.0420)	(0.0049)	(0.0371)
lag1_MPK	0.6925**	0.4756	0.5257***	0.2422
	(0.2560)	(0.2855)	(0.0813)	(0.2886)
lag1_CF	0.2398***	0.0410	0.0144	0.3647***
	(0.0452)	(0.0558)	(0.0077)	(0.0834)
lag2_I	-0.0314*	0.0330	-0.0062	-0.0231
	(0.0159)	(0.0238)	(0.0035)	(0.0218)
lag2_D_tot	0.0110	-0.0124	-0.0007	0.0078
	(0.0184)	(0.0263)	(0.0028)	(0.0228)
lag2_MPK	0.4165*	0.0632	0.1195*	0.1291
	(0.2008)	(0.1461)	(0.0478)	(0.1390)
lag2_CF	0.0423	-0.0300	0.0017	0.0495
	(0.0292)	(0.0354)	(0.0041)	(0.0533)

*** p < 0.001; ** p < 0.01; * p < 0.05

Number of observations: 7,068

Number of groups: 1,985

Hansen test: chi2(176) = 182.42 Prob > chi2 = 0.354

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A41: Eigenvalue stability condition for small companies with two lags

	Eigenvalue	Modulus
1	0.59717601+0.0000000i	0.59717601
2	0.39831970+0.0000000i	0.39831970
3	-0.19351313+0.0000000i	0.19351313
4	0.18347150+0.0000000i	0.18347150
5	-0.04028428+0.1441129i	0.14963741
6	-0.04028428-0.1441129i	0.14963741
7	-0.07785209+0.0000000i	0.07785209
8	-0.07481686+0.0000000i	0.07481686

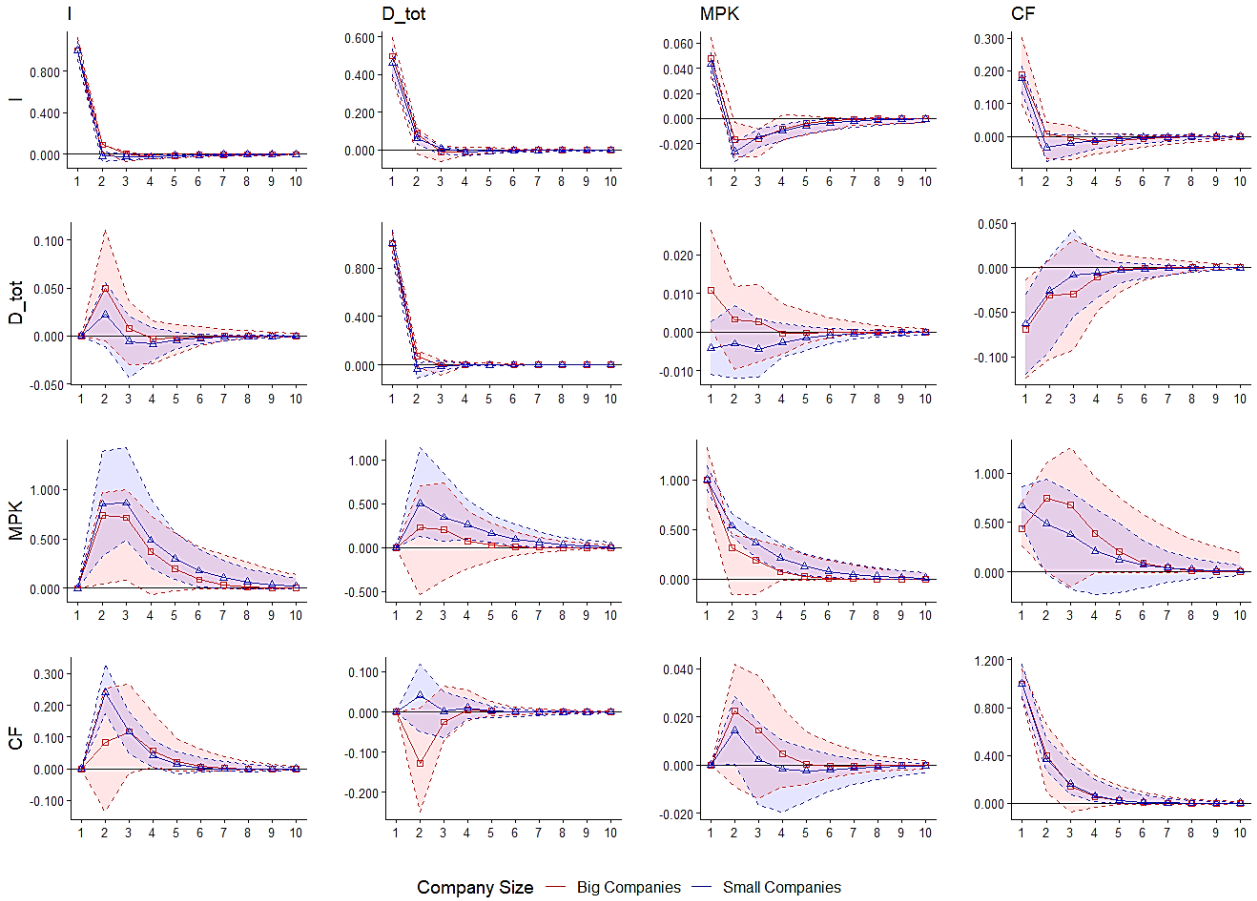
Sources: AJPES, own work.

Table A42: Andrews-Lu criteria for small companies with two lags

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,998.287	-281.753	-920.608
2	-1,909.326	-289.580	-898.940
3	-1,805.014	-279.379	-859.625

Sources: AJPES, own work.

Figure A2: Impulse responses for the estimation with two lags



Note: I – investment rate (investment-to-capital ratio), D_tot – debt rate (total debt-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws.

Sources: AJPES, own work.

Table A43: Estimated coefficients for large companies with additional sectors

	I	D_tot	MPK	CF
lag1_I	0.0797*	0.1271**	-0.0299*	-0.1379***
	(0.0377)	(0.0459)	(0.0133)	(0.0363)
lag1_D_tot	-0.0791*	-0.1247**	-0.0170*	-0.0302
	(0.0357)	(0.0479)	(0.0076)	(0.0257)
lag1_MPK	0.2072	0.3270	0.2587	-0.0707
	(0.1701)	(0.1923)	(0.1362)	(0.1404)
lag1_CF	0.0740	0.0160	0.0330	0.4810***
	(0.0769)	(0.0952)	(0.0174)	(0.1120)
*** p < 0.001; ** p < 0.01; * p < 0.05				
Number of observations: 5,672				
Number of groups: 788				
Hansen test: chi2(192) = 241.94 Prob > chi2 = 0.008				

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A44: Eigenvalue stability condition for large companies with additional sectors

	Eigenvalue	Modulus
1	0.43229024	0.43229024
2	0.23781686	0.23781686
3	0.07029615	0.07029615
4	-0.04584616	0.04584616

Sources: AJPES, own work.

Table A45: Andrews-Lu criteria for large companies with additional sectors

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,858.379	-244.058	-858.665
2	-1,788.225	-255.177	-843.558
3	-1,730.140	-277.302	-839.568

Sources: AJPES, own work.

Table A46: Estimated coefficients for small companies with additional sectors

	I	D_tot	MPK	CF
lag1_I	-0.0924***	-0.0209	-0.0424***	-0.2186***
	(0.0180)	(0.0278)	(0.0040)	(0.0323)
lag1_D_tot	0.0564**	0.0437	0.0012	0.0210
	(0.0182)	(0.0295)	(0.0020)	(0.0197)
lag1_MPK	0.9077***	0.6048***	0.4801***	0.7069***
	(0.1269)	(0.1836)	(0.0427)	(0.2012)
lag1_CF	0.1094***	-0.0040	0.0050	0.4157***
	(0.0227)	(0.0344)	(0.0034)	(0.0593)
*** p < 0.001; ** p < 0.01; * p < 0.05				
Number of observations: 22,292				
Number of groups: 5,920				
Hansen test: chi2(192) = 259.93 Prob > chi2 = 0.001				

Note: I – investment rate (investment to capital ratio), D_tot – debt rate (total debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A47: Eigenvalue stability condition for small companies with additional sectors

	Eigenvalue	Modulus
1	0.380861991+0.0402809i	0.382986169
2	0.380861991-0.0402809i	0.382986169
3	0.089921503+0.0000000i	0.089921503
4	-0.004456687+0.0000000i	0.004456687

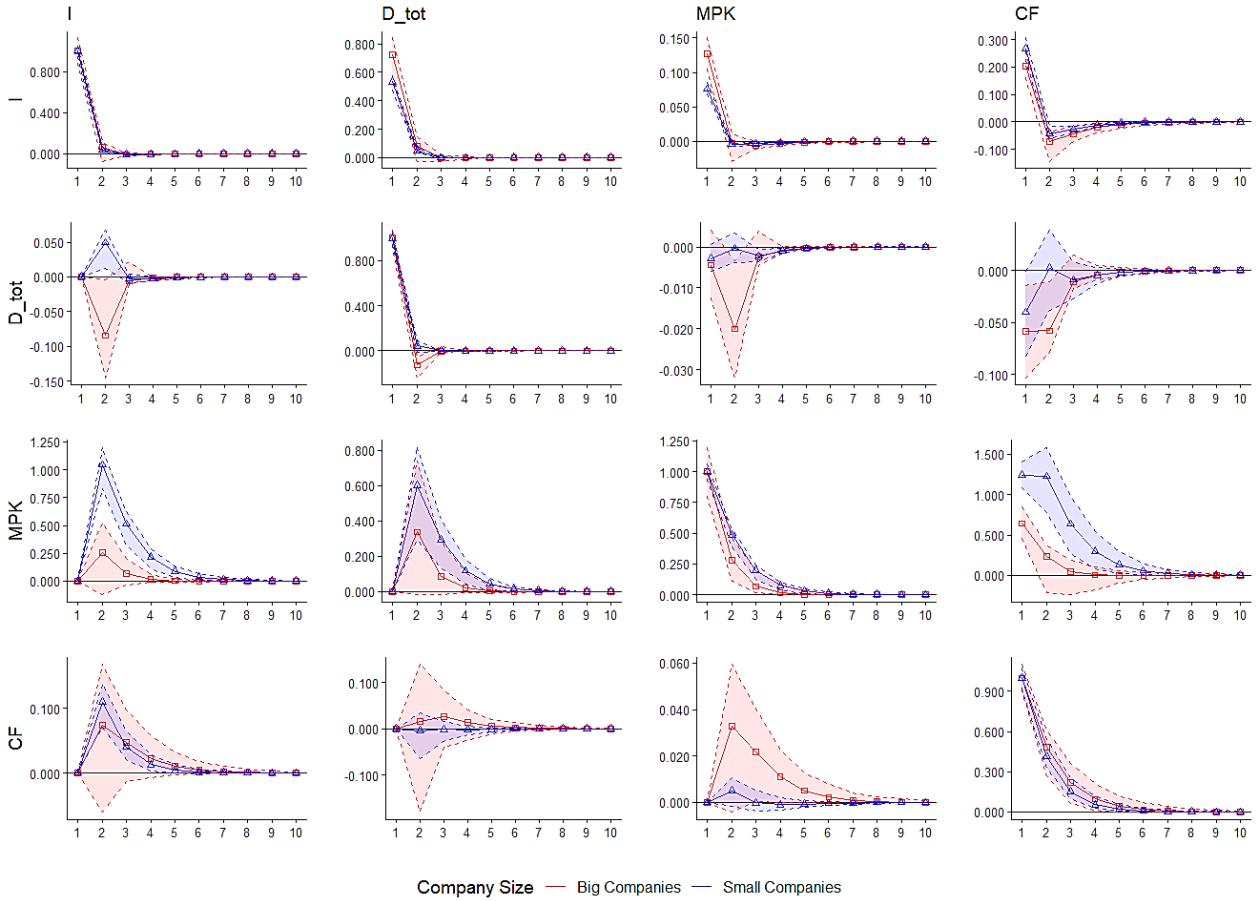
Sources: AJPES, own work.

Table A48: Andrews-Lu criteria for small companies with additional sectors

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-2,172.987	-226.075	-915.695
2	-2,091.336	-250.546	-909.693
3	-2,006.061	-268.388	-897.473

Sources: AJPES, own work.

Figure A3: Impulse responses for the estimation with additional sectors



Note: I – investment rate (investment-to-capital ratio), D_tot – debt rate (total debt-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws.

Sources: AJPES, own work.

Table A49: Estimated coefficients for large companies with long-term debt

	I	D_lr	MPK	CF
lag1_I	0.0719*	0.0692**	-0.0254**	-0.1259***
	(0.0333)	(0.0266)	(0.0078)	(0.0320)
lag1_D_lr	0.0587	-0.0236	-0.0025	0.0280
	(0.0323)	(0.0325)	(0.0043)	(0.0259)
lag1_MPK	0.2065	0.0602	0.2236*	0.3145
	(0.1468)	(0.1501)	(0.1010)	(0.1924)
lag1_CF	0.1167	-0.0727	0.0220	0.4992***
	(0.0902)	(0.0588)	(0.0132)	(0.0941)
*** p < 0.001; ** p < 0.01; * p < 0.05				
Number of observations: 3,221				
Number of groups: 441				
Hansen test: chi2(192) = 221.31 Prob > chi2 = 0.072				

Note: I – investment rate (investment to capital ratio), D_lr – long-term debt rate (long-term debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A50: Eigenvalue stability condition for large companies with long-term debt

	Eigenvalue	Modulus
1	0.47622622+0.0000000i	0.47622622
2	0.16756983+0.0316506i	0.17053272
3	0.16756983-0.0316506i	0.17053272
4	-0.04029249+0.0000000i	0.04029249

Sources: AJPES, own work.

Table A51: Andrews-Lu criteria for large companies with long-term debt

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,741.512	-264.692	-844.747
2	-1,692.713	-293.015	-847.288
3	-1,605.117	-281.524	-810.110

Sources: AJPES, own work.

Table A52: Estimated coefficients for small companies with long-term debt

	I	D_lr	MPK	CF
lag1_I	-0.0832***	0.0084	-0.0414***	-0.0739
	(0.0239)	(0.0189)	(0.0057)	(0.0377)
lag1_D_lr	0.0698*	0.0031	0.0098**	-0.0492
	(0.0282)	(0.0233)	(0.0038)	(0.0446)
lag1_MPK	0.7602***	0.2240	0.4263***	0.0972
	(0.2053)	(0.1410)	(0.0657)	(0.2545)
lag1_CF	0.1546***	0.0111	0.0072	0.3706***
	(0.0387)	(0.0277)	(0.0051)	(0.0570)

*** p < 0.001; ** p < 0.01; * p < 0.05

Number of observations: 8,638

Number of groups: 1,985

Hansen test: chi2(192) = 211.46 Prob > chi2 = 0.16

Note: I – investment rate (investment to capital ratio), D_lr – long-term debt rate (long-term debt to capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash flow to capital ratio). Standard errors are reported in parentheses.

Sources: AJPES, own work.

Table A53: Eigenvalue stability condition for small companies with long-term debt

	Eigenvalue	Modulus
1	0.37375074	0.37375074
2	0.31554654	0.31554654
3	0.07050440	0.07050440
4	-0.04306126	0.04306126

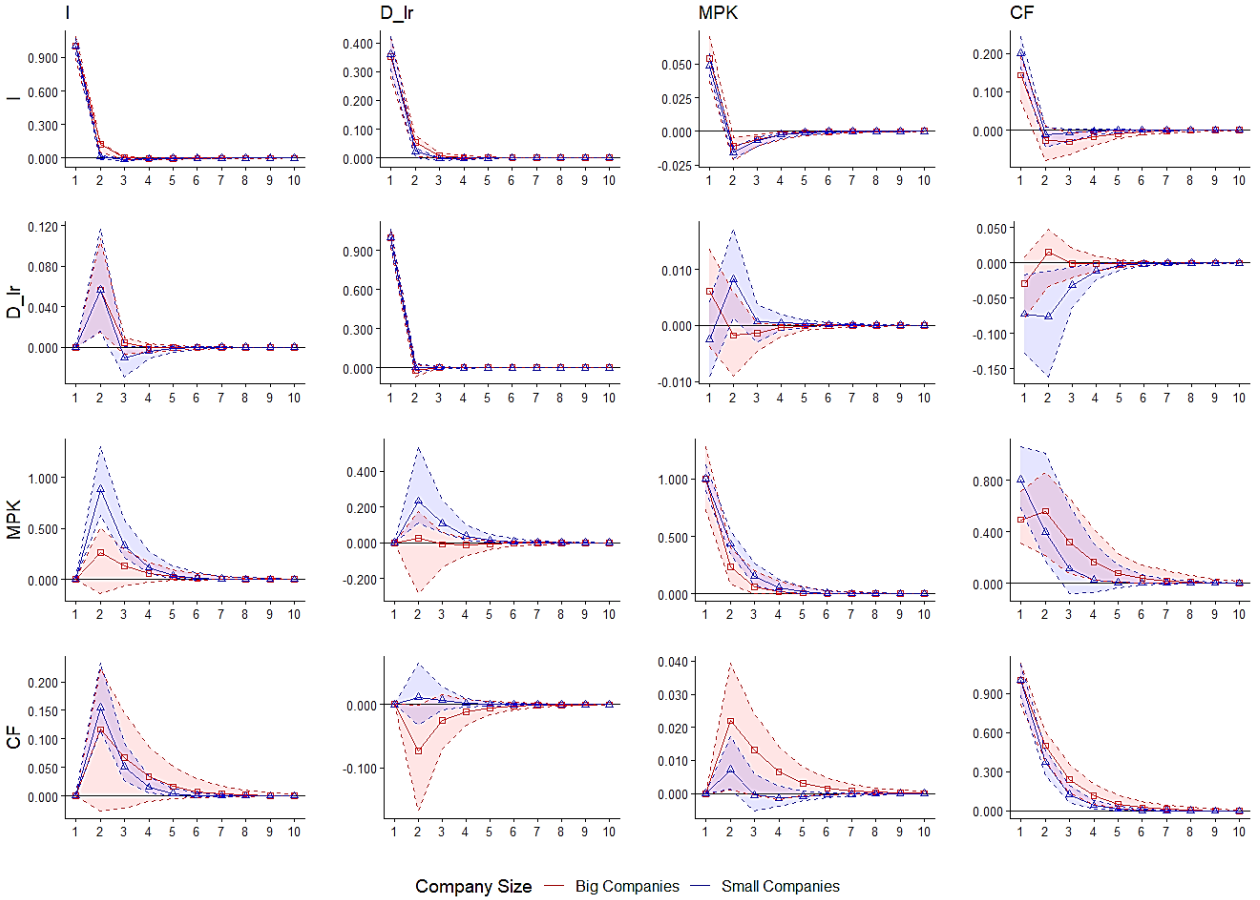
Sources: AJPES, own work.

Table A54: Andrews-Lu criteria for small companies with long-term debt

Criterion / N. of lags	MMSC_BIC	MMSC_AIC	MMSC_HQIC
1	-1,991.070	-274.536	-913.392
2	-1,881.212	-261.465	-870.826
3	-1,778.853	-253.219	-833.465

Sources: AJPES, own work.

Figure A4: Impulse responses for the estimation with long-term debt



Note: I – investment rate (investment-to-capital ratio), D_lr – long-term debt rate (long-term debt-to-capital ratio), MPK – marginal productivity of capital, CF – cash flow rate (cash-flow-to-capital ratio). Horizontal and vertical axes represent years after the initial shock and the variable responses in percentage points, respectively. Dashed lines denote 90% confidence intervals generated by 100 draws.

Sources: AJPES, own work.

Appendix 6: Chapter 4 – Derivation of the theoretical model

3 – period credit market model

A6.1 Notation

In the derivation presented in this section, we use the following notation:

B_t – Amount of borrowing for firm

D_t^B – Dividends to banks' shareholders

D_t^F – Dividends to firms' shareholders

δ – Depreciation rate

$E_t^B[.]$ – Bank's expectations based on the information available in period *t*

$E_t^F[.]$ – Firm's expectations based on the information available in period *t*

ε_t – Production shock

$\underline{\varepsilon}$ – Lower bound of production shock

$\overline{\varepsilon}$ – Upper bound of production shock

$\underline{\varepsilon}^B$ – Lower bound of production shock expected by the bank

ε_t^B – Production shock excepted by the bank

ε_t^* – High production shock

$\hat{\varepsilon}_t$ – Threshold level of production shock, below which the firm demands external finance

$G(B_t)$ – Expected return to loans

I_t – Investment in production

I_t^* – Optimal investment in production

I_t – Suboptimal investment in production, financed from internal sources

I_t – Suboptimal investment in production, financed from internal and external sources

K_t – Firm's capital stock

L_t – Firm's liquidity reserves

L_t^B – Bank's liquidity reserves

P^B – Bank's probability of observing productivity shock

P^F – Firm's probability of observing productivity shock

r_B – Bank's return on liquidity investment

r_L – Return on liquid assets

ρ – Risk-free rate of return

θ – Fixed cost of borrowing

V_1 – Solution to the firm's optimisation problem in period *t*

V_1^B – Solution to the bank's optimisation problem in period *t*

X_0^B – Bank's initial endowment

X_0^F – Firm's initial endowment

Y_t – Firm's output

A6.2 Firms

Initial endowment: X_0^F

Law of motion for capital:

$$K_0 = 0$$
$$K_1 = (1-\delta)0 + I_0$$
$$K_2 = (1-\delta)K_1 + I_1; \quad K_1 = I_0$$

Production function:

$$Y_t = F(I_{t-1}) + \varepsilon_t$$

$F(I_{t-1})$ is twice continuously differentiable, strictly increasing and strictly concave function, with $F(0) = 0$, $F'(0) = \infty$, and $F'(z) \to 0$ as $z \to \infty$.

Production shock:

$$\varepsilon_t \sim U\left[\underline{\varepsilon}, \bar{\varepsilon}\right]$$
$$E\left(\varepsilon_t\right) = 0$$

ε_t is independently and identically uniformly distributed.

Law of motion for deposits:

L_0 is chosen according to the optimisation principle.

$$L_1 = \left(1 + r_L\right) L_0; \quad r_L < \rho$$

Law of motion for dividends for firms' shareholders:

$$D_0^F = X_0^F - I_0 - L_0$$
$$D_1^F = F\left(I_0\right) + \varepsilon_1 + L_0\left(1 + r_L\right) + B_1(1-\theta) - I_1$$
$$D_2^F = \max\left[F\left(I_1\right) + \varepsilon_2 - G\left(B_1\right); 0\right]$$

A6.3 Banks

Initial endowment: X_0^B

Expected return to loans function

$G(B_1)$ is twice continuously differentiable, strictly increasing, and strictly concave function, with $G(0)=0$, $G'(0)=\infty$, and $G'(z)\to 0$ as $z\to\infty$.

Law of motion for dividends for banks' shareholders:

$$D_0^B = X_0^B - L_0^B$$
$$D_1^B = L_0^B(1+r_B) - B_1(1-\theta); \quad r_B > \rho; \quad B_1(1-\theta) \le L_0^B(1+r_L)$$
$$D_2^B = \min\left[F(I_1)+\varepsilon_2; G(B_1)\right]$$

Production shock observed by the bank:

$$\varepsilon_t^B \sim U\left[\underline{\varepsilon}^B, \overline{\varepsilon}\right]$$
$$E\left(\varepsilon_t^B\right) < 0$$
$$E\left(\varepsilon_t^B\right) = \frac{\underline{\varepsilon}^B + \overline{\varepsilon}}{2}$$
$$= \frac{\underline{\varepsilon} + \overline{\varepsilon}}{2} + \frac{\underline{\varepsilon}^B - \underline{\varepsilon}}{2}$$
$$= \frac{\underline{\varepsilon}^B - \underline{\varepsilon}}{2}$$

A6.4 Optimisation in period *t* = 1

A6.4.1 Firm's optimisation problem

$$\max_{\{B_1, I_1\}} \left\langle D_1^F + (1+\rho)^{-1} E_1^F\left[D_2^F\right]\right\rangle$$
s.t.
$$D_1^F \ge 0$$
$$I_1 \ge 0$$
$$B_1 \ge 0$$
$$D_1^F = F(I_0) + \varepsilon_1 + L_0(1+r_L) + B_1(1-\theta) - I_1$$
$$E_1^F\left[D_2^F\right] = \int_{\underline{\varepsilon_2}}^{\overline{\varepsilon_2}} \max\left[F(I_1)+\varepsilon_2 - G(B_1); 0\right] g(\varepsilon_2)\, d\varepsilon_2$$

$g(.)$ denotes the probability density function of ε_t, $E_1^F[.]$ denotes the firms' expectations about the developments in period two based on the information available in period one. To solve the constrained optimisation problem, we form the Lagrangian:

$$\begin{aligned}
Q_1^F(I_1, B_1, \lambda_1) &= D_1^F + (1+\rho)^{-1} E_1\left(D_2^F\right) + \lambda_1 D_1^F \\
&= F(I_0) + \varepsilon_1 + L_0(1+r_L) + B_1(1-\theta) - I_1 + \\
&+ (1+\rho)^{-1} \int_{\underline{\varepsilon}_2}^{\bar{\varepsilon}_2} \max\left[F(I_1) + \varepsilon_2 - G(B_1); 0\right] g(\varepsilon_2)\, d\varepsilon_2 + \lambda_1 D_1^F \\
&= F(I_0) + \varepsilon_1 + L_0(1+r_L) + B_1(1-\theta) - I_1 + \\
&+ (1+\rho)^{-1} \left(\int_{\varepsilon_2^*}^{\bar{\varepsilon}_2} \left[F(I_1) + \varepsilon_2 - G(B_1)\right] g(\varepsilon_2)\, d\varepsilon_2 + \int_{\underline{\varepsilon}_2}^{\varepsilon_2^*} 0 \cdot g(\varepsilon_2)\, d\varepsilon_2 \right) + \lambda_1 D_1^F \\
&= F(I_0) + \varepsilon_1 + L_0(1+r_L) + B_1(1-\theta) - I_1 + \\
&+ (1+\rho)^{-1} \left(\left[F(I_1) - G(B_1)\right] \frac{\bar{\varepsilon}_2 - \varepsilon_2^*}{\bar{\varepsilon}_2 - \underline{\varepsilon}_2} + \frac{\bar{\varepsilon}_2^{\,2} - \varepsilon_2^{*2}}{2(\bar{\varepsilon}_2 - \underline{\varepsilon}_2)} \right) + \lambda_1 D_1^F
\end{aligned}$$

$$\begin{aligned}
Q_1^F(I_1, B_1, \lambda_1) &= F(I_0) + \varepsilon_1 + L_0(1+r_L) + B_1(1-\theta) - I_1 + \\
&+ (1+\rho)^{-1} \left(\left[F(I_1) - G(B_1)\right] P^F(\varepsilon_2 > \varepsilon_2^*) + \frac{\bar{\varepsilon}_2^{\,2} - \varepsilon_2^{*2}}{2(\bar{\varepsilon}_2 - \underline{\varepsilon}_2)} \right) + \lambda_1 D_1^F
\end{aligned}$$

Based on the Lagrangian, we obtain the following first-order conditions:

$$\frac{\partial Q_1^F}{\partial I_1} = -(1+\lambda_1) + (1+\rho)^{-1} F'(I_1) P^F\left(\varepsilon_2 > \varepsilon_2^*\right) \le 0; \quad I_1 \ge 0; \quad I_1 \frac{\partial Q^F}{\partial I_1} = 0$$

$$\frac{\partial Q_1^F}{\partial B_1} = (1-\theta) + \lambda_1(1-\theta) - (1+\rho)^{-1} G'(B_1) P^F\left(\varepsilon_2 > \varepsilon_2^*\right) \le 0; \quad B_1 \ge 0; \quad B_1 \frac{\partial Q^F}{\partial B_1} = 0$$

$$\frac{\partial Q_1^F}{\partial \lambda_1} = D_1^F \ge 0; \quad \lambda_1 \ge 0; \quad \lambda_1 \frac{\partial Q_1^F}{\partial \lambda_1} = 0$$

A6.4.2 Bank's optimisation problem

Similarly, banks optimise their decisions based on the expected result in period two:

$$\max_{\{B_1, L_1^B\}} \left\langle D_1^B + (1+\rho)^{-1} E_1^B \left[D_2^B \right] \right\rangle$$

s.t.

$$D_1^B \geq 0$$

$$L_1^B \geq 0$$

$$B_1 \geq 0$$

$$D_1^B = L_0^B (1+r_B) - B_1(1-\theta) - L_1^B$$

$$E_1^B \left[D_2^B \right] = \int_{\underline{\varepsilon_2^B}}^{\overline{\varepsilon_2}} \min \left[F(I_1) + \varepsilon_2; G(B_1) \right] g(\varepsilon_2) d\varepsilon_2$$

We solve the problem by forming the Lagrangian:

$$\begin{aligned} Q_1^B \left(L_1^B, B_1, \mu_1 \right) &= D_1^B + (1+\rho)^{-1} E_1 \left(D_2^B \right) + \mu_1 D_1^B \\ &= L_0^B \left(1+r_B\right) - B_1(1-\theta) + (1+\rho)^{-1} \int_{\underline{\varepsilon_2^B}}^{\overline{\varepsilon}_2} \left[F\left(I_1\right) + \varepsilon_2; G\left(B_1\right) \right] g\left(\varepsilon_2\right) d\varepsilon_2 + \\ &\quad + (1+\rho)^{-1} L_1^B \left(1+r_B\right) + \mu_1 D_1^B \\ &= L_0^B \left(1+r_B\right) - B_1(1-\theta) + (1+\rho)^{-1} \int_{\underline{\varepsilon_2^B}}^{\varepsilon_2^*} \left[F\left(I_1\right) + \varepsilon_2 \right] g\left(\varepsilon_2\right) d\varepsilon_2 + \\ &\quad + \int_{\varepsilon_2^*}^{\overline{\varepsilon}_2} G\left(B_1\right) g\left(\varepsilon_2\right) d\varepsilon_2 + (1+\rho)^{-1} L_1^B \left(1+r_B\right) + \mu_1 D_1^B \end{aligned}$$

$$Q_1^B \left(L_1^B, B_1, \mu_1 \right) = L_0^B \left(1+r_B\right) - B_1(1-\theta) + (1+\rho)^{-1} F\left(I_1\right) \frac{\varepsilon_2^* - \varepsilon_2^B}{\overline{\varepsilon}_2 - \underline{\varepsilon_2^B}} + \frac{\varepsilon_2^{*2} - \varepsilon_2^{B2}}{2\left(\overline{\varepsilon}_2 - \underline{\varepsilon_2^B}\right)} +$$

$$+ G\left(B_1\right) \frac{\overline{\varepsilon}_2 - \varepsilon_2^*}{\overline{\varepsilon}_2 - \underline{\varepsilon_2^B}} + (1+\rho)^{-1} L_1^B \left(1+r_B\right) + \mu_1 D_1^B$$

Based on the Lagrangian, we obtain the following first-order conditions:

$$\frac{\partial Q_1^B}{\partial B_1} = -(1-\theta) - \mu_1(1-\theta) + (1+\rho)^{-1} G'\left(B_1\right) \frac{\overline{\varepsilon}_2 - \varepsilon_2^*}{\overline{\varepsilon}_2 - \varepsilon_2^B} \leq 0; \quad B_1 \geq 0; \quad B_1 \frac{\partial Q_1^B}{\partial B_1} = 0$$

$$\frac{\partial Q_1^B}{\partial L_1^B} = -1 - \mu_1 + (1+\rho)^{-1} \left(1+r_B\right) \leq 0; \quad L_1^B \geq 0; \quad L_1^B \frac{\partial Q_1^B}{\partial L_1^B} = 0$$

$$\frac{\partial Q_1^D}{\partial \mu_1} = D_1^B \geq 0; \quad \mu_1 \geq 0; \quad \mu_1 \frac{\partial Q_1^B}{\partial \mu_1} = 0$$

A6.4.3 Optimal level of investment in period one

1. ε_1 is high $\varepsilon_1 \in \left[\varepsilon_1^*, \bar{\varepsilon}_1\right]$

$B_1 = 0$
$I_1 > 0$
$D_1^F > 0 \rightarrow \lambda_1 = 0$

$$(1+\rho)^{-1} F'(I_1) P^F\left(\varepsilon_2 > \varepsilon_2^*\right) = 1$$

$$F'\left(I_1^*\right) = \frac{1+\rho}{P^F\left(\varepsilon_2 > \varepsilon_2^*\right)}$$

2. ε_1 is low $\varepsilon_1 \in \left[\underline{\varepsilon}_1, \hat{\varepsilon}_1\right]$

$D_1^F = 0 \rightarrow \lambda_1 > 0$
$B_1 > 0$
$I_1 > 0$

$$-\left(1+\lambda_1\right) + (1+\rho)^{-1} F'(I_1) P^F\left(\varepsilon_2 > \varepsilon_2^*\right) = 0$$

$$(1-\theta) + \lambda_1(1-\theta) - (1+\rho)^{-1} G'(B_1) P^F\left(\varepsilon_2 > \varepsilon_2^*\right) = 0 \rightarrow$$

$$\rightarrow \begin{array}{c} \lambda_1(1-\theta) = \frac{1}{1+\rho} G'(B_1) P^F\left(\varepsilon_2 > \varepsilon_2^*\right) - (1-\theta) \\ \lambda_1 = \frac{1}{1+\rho} G'(B_1) P^F\left(\varepsilon_2 > \varepsilon_2^*\right) \frac{1}{(1-\theta)} - 1 \end{array}$$

$$-(1-\theta) - \mu_1(1-\theta) + (1+\rho)^{-1} G'(B_1) \frac{\bar{\varepsilon}_2 - \varepsilon_2^*}{\bar{\varepsilon}_2 - \underline{\varepsilon}^B} = 0$$

$$P^B\left(\varepsilon_2 > \varepsilon_2^*\right) < P^F\left(\varepsilon_2 > \varepsilon_2^*\right)$$

Thus, $\frac{\bar{\varepsilon}_2 - \varepsilon_2^*}{\bar{\varepsilon}_2 - \underline{\varepsilon}^B}$ is lower than the optimum.

$$(1+\rho)^{-1} F'(I_1) P^F\left(\varepsilon_2 > \varepsilon_2^*\right) = \left(1+\lambda_1\right)$$

Joining the solution with the expression of the Lagrange multiplier:

$$(1+\rho)^{-1}F'(I_1)P^F\left(\varepsilon_2 > \varepsilon_2^*\right) = \frac{1}{(1+\rho)(1-\theta)}G'(B_1)P^F\left(\varepsilon_2 > \varepsilon_2^*\right)$$

$$F'\left(\hat{I}_1\right) = \frac{G'(B_1)}{(1-\theta)}$$

From the bank's optimisation problem, we obtain:

$\mu_1 > 0$, meaning everything is invested or lent out (it makes no sense to pay out as $(1+r_B) > (1+\rho)$)

$$\mu_1 = \frac{1+r_B}{1+\rho} - 1$$

$$-(1-\theta) - \mu_1(1-\theta) + (1+\rho)^{-1}G'(B_1)P^B\left(\varepsilon_2 > \varepsilon_2^*\right) = 0$$

$$\begin{aligned}
G'(B_1) &= \frac{1+\rho}{P^B\left(\varepsilon_2 > \varepsilon_2^*\right)}\left[(1-\theta) + \mu_1(1-\theta)\right] \\
&= \frac{1+\rho}{P^B\left(\varepsilon_2 > \varepsilon_2^*\right)}\left[1-\theta+\left(\frac{1+r_B}{1+\rho}-1\right)(1-\theta)\right] \\
&= \frac{1+\rho}{P^B\left(\varepsilon_2 > \varepsilon_2^*\right)}(1-\theta)\left[1+\frac{1+r_B}{1+\rho}-1\right] \\
&= \frac{1+\rho}{P^B\left(\varepsilon_2 > \varepsilon_2^*\right)}(1-\theta)\frac{1+r_B}{1+\rho} \\
&= \frac{(1-\theta)(1+r_B)}{P^B\left(\varepsilon_2 > \varepsilon_2^*\right)}
\end{aligned}$$

$$F'\left(\hat{I}_1\right) = \frac{1+r_B}{P^B\left(\varepsilon_2 > \varepsilon_2^*\right)}$$

3. $\varepsilon_1 \in \left[\hat{\varepsilon}_1, \varepsilon_1^*\right]$

$B_1 = 0$
$D_1^F = 0 \rightarrow \lambda_1 > 0$
$I_1 > 0$

$$-(1+\lambda_1) + (1+\rho)^{-1}F'(I_2)P^F\left(\varepsilon_2 > \varepsilon_2^*\right) = 0$$

$$F'(I_1) = \frac{(1+\lambda_1)(1+\rho)}{P^F\left(\varepsilon_2 > \varepsilon_2^*\right)}$$

$$\frac{1+\rho}{P^F\left(\varepsilon_2 > \varepsilon_2^*\right)} \leq F'\left(\tilde{I}_1\right) \leq \frac{1+r_B}{P^B\left(\varepsilon_2 > \varepsilon_2^*\right)}$$

Since $\frac{1+\rho}{P^F\left(\varepsilon_2 > \varepsilon_2^*\right)} < \frac{1+r_B}{P^B\left(\varepsilon_2 > \varepsilon_2^*\right)}$ it holds that $\hat{I}_1 \leq \tilde{I}_1 \leq I_1^*$. This implies an intermediate case, where the production shock is not low enough to justify borrowing, yet the firm is expected to underinvest since the funds are insufficient for the investment level I^*. Note that $r_B \to \rho$ and $\underline{\varepsilon}_2^B \to \underline{\varepsilon}_2$ would imply perfect capital markets and no agent problem. Hence, there is no intermediate case and investment is not dependent on ε_1.

A6.5 Optimisation in period *t* = 0

A6.5.1 Firm's optimisation problem

Optimisation in period zero is based on results obtained in period one:

$$\max_{\{L_0, I_0\}} \left\langle D_0^F + (1+\rho)^{-1} E_0^F \left[V_1\right]\right\rangle$$

s.t.

$$D_0^F \geq 0$$

$$I_0 \geq 0$$

$$L_0 \geq 0$$

$$D_0^F = X_0^F - L_0 - I_0$$

$$V_1 = \max_{\{B_1, I_1\}} \left\langle D_1^F + (1+\rho)^{-1} E_1^F \left[D_2^F \right]\right\rangle$$

We form the Lagrangian:

$$Q(I_0, L_0, \lambda_0) = \left[X_0^F - I_0 - L_0 \right] +$$
$$+ \frac{1}{(1+\rho)} \int_{\varepsilon_1^*}^{\bar{\varepsilon}_1} \left[F(I_0) + \varepsilon_1 + L_0(1+r_L) - I_1^* \right] g(\varepsilon_1) d\varepsilon_1 +$$
$$+ \frac{1}{(1+\rho)^2} \int_{\varepsilon_1^*}^{\bar{\varepsilon}_1} \int_{\underline{\varepsilon}_2}^{\bar{\varepsilon}_2} \left[F(I_1^*) + \varepsilon_2 \right] g(\varepsilon_2) g(\varepsilon_1) d\varepsilon_2 d\varepsilon_1 +$$
$$+ \frac{1}{(1+\rho)^2} \int_{\hat{\varepsilon}_1}^{\varepsilon_1^*} \int_{\underline{\varepsilon}_2}^{\bar{\varepsilon}_2} \left[F(F(I_0) + \varepsilon_1 + L_0(1+r_L)) + \varepsilon_2 \right] g(\varepsilon_2) g(\varepsilon_1) d\varepsilon_2 d\varepsilon_1 +$$
$$+ \frac{1}{(1+\rho)^2} \int_{\varepsilon_1}^{\hat{\varepsilon}_1} \int_{\varepsilon_2^*}^{\bar{\varepsilon}_2} \left[F(\hat{I}_1) + \varepsilon_2 - G(B_1) \right] g(\varepsilon_2) g(\varepsilon_1) d\varepsilon_2 d\varepsilon_1 + \lambda_0 \left[X_0^F - I_0 - L_0 \right]$$

$$Q(I_0, L_0, \lambda_0) = \left[X_0^F - I_0 - L_0 \right] +$$
$$+ \frac{1}{(1+\rho)} \int_{\varepsilon_1^*}^{\bar{\varepsilon}_1} \left[F(I_0) + \varepsilon_1 + L_0(1+r_L) - I_1^* \right] g(\varepsilon_1) d\varepsilon_1 +$$
$$+ \frac{1}{(1+\rho)^2} \int_{\varepsilon_1^*}^{\bar{\varepsilon}_1} \left[F(I_1^*) + E(\varepsilon_2) \right] g(\varepsilon_1) d\varepsilon_1 +$$
$$+ \frac{1}{(1+\rho)^2} \int_{\hat{\varepsilon}_1}^{\varepsilon_1^*} \left[F(F(I_0) + \varepsilon_1 + L_0(1+r_L)) \right] g(\varepsilon_1) d\varepsilon_1 +$$
$$+ \frac{1}{(1+\rho)^2} \int_{\varepsilon_1}^{\hat{\varepsilon}_1} \left[\left(F(\hat{I}_1) - G(B_1) \right) \frac{\bar{\varepsilon}_2 - \varepsilon_2^*}{\bar{\varepsilon}_2 - \underline{\varepsilon}_2} + \frac{\bar{\varepsilon}_2^2 - \varepsilon_2^{*2}}{2(\bar{\varepsilon}_2 - \underline{\varepsilon}_2)} \right] g(\varepsilon_1) d\varepsilon_1 +$$
$$+ \lambda_0 \left[X_0^F - I_0 - L_0 \right]$$

Based on the Lagrangian, we obtain the following first-order conditions:

$$\frac{\partial Q_0^F}{\partial I_0} = -(1+\lambda_0) + \frac{1}{1+\rho} \frac{\partial}{\partial I_0} \left[\left[F(I_0) + L_0(1+r_L) - I_1^* \right] \frac{\bar{\varepsilon}_1 - \varepsilon_1^*}{\bar{\varepsilon}_1 - \underline{\varepsilon}_1} + \frac{\bar{\varepsilon}_1^2 - \varepsilon_1^{*2}}{2(\bar{\varepsilon}_1 - \underline{\varepsilon}_1)} \right] +$$
$$+ \frac{1}{(1+\rho)^2} \frac{\partial}{\partial I_0} \left[F(I_1^*) \frac{\bar{\varepsilon}_1 - \varepsilon_1^*}{\bar{\varepsilon}_1 - \underline{\varepsilon}_1} \right] +$$
$$+ \frac{1}{(1+\rho)^2} Z +$$
$$+ \frac{1}{(1+\rho)^2} \frac{\partial}{\partial I_0} \left(\left[F(\hat{I}_1) - G(B_1) \right] \frac{\bar{\varepsilon}_2 - \varepsilon_2^*}{\bar{\varepsilon}_2 - \underline{\varepsilon}_2} + \frac{\bar{\varepsilon}_2^2 - \varepsilon_2^{*2}}{2(\bar{\varepsilon}_2 - \underline{\varepsilon}_2)} \right) \cdot \frac{\hat{\varepsilon}_1 - \varepsilon_1}{\bar{\varepsilon}_1 - \varepsilon_1}$$

$$\frac{\partial Q_0^F}{\partial I_0} = -(1+\lambda_0) + \frac{1}{1+\rho} \left(F'(I_0) \right) P^F \left(\varepsilon_1 > \varepsilon_1^* \right) + \frac{1}{(1+\rho)^2} Z \le 0; \quad I_0 \ge 0; \quad I_0 \frac{\partial Q_0^F}{\partial I_0} = 0$$

$$\frac{\partial Q_0^F}{\partial L_0} = -(1+\lambda_0) + \frac{1}{1+\rho}(1+r_L)P^F\left(\varepsilon_1 > \varepsilon_1^*\right) + \frac{1}{(1+\rho)^2}Z \le 0; \quad L_0 \ge 0; \quad L_0 \frac{\partial Q_0^F}{\partial L_0} = 0$$

$$\frac{\partial Q_0{}^F}{\partial \lambda_0} = \left[X_0{}^F - I_0 - L_0 \right] \ge 0; \quad \lambda_0 \ge 0; \quad \lambda_0 \frac{\partial Q_0{}^F}{\partial \lambda_0} = 0$$

$$Z = \int_{\varepsilon_1}^{\varepsilon_1^*} F'\left[F(I_0) + \varepsilon_1 + L_0(1+r_L)\right] g(\varepsilon_1) d\varepsilon_1$$

We assume that X_o^F is high enough so that $D_0^F > 0$ for any optimal choice of I_0 and L_0 ($\lambda_0 = 0$):

$$F'(0) = \infty \to I_0 > 0 \to \frac{\partial Q_0{}^F}{\partial I_0} = 0$$

$$\frac{1}{1+\rho}\left(F'\left(I_0\right)\right)P^F\left(\varepsilon_1 > \varepsilon_1^*\right) + \frac{1}{(1+\rho)^2}Z = 1$$

$$\frac{1}{1+\rho}F'\left(I_0\right)P^F\left(\varepsilon_1 > \varepsilon_1^*\right) = 1 - \frac{1}{(1+\rho)^2}Z$$

$$F'\left(I_0\right) = \frac{1+\rho}{P^F\left(\varepsilon_1 > \varepsilon_1^*\right)} - \frac{1}{(1+\rho)P^F\left(\varepsilon_1 > \varepsilon_1^*\right)}Z$$

– If $L_0 > 0$:

$$\frac{1}{1+\rho}(1+r_L)P^F\left(\varepsilon_1 > \varepsilon_1^*\right) + \frac{1}{(1+\rho)^2}Z = 1 \quad \to \quad F'\left(I_0\right) = (1+r_L)$$

– If $L_0 = 0$:

$$F'\left(I_0\right) = \frac{1+\rho}{P^F\left(\varepsilon_1 > \varepsilon_1^*\right)} - \frac{1}{(1+\rho)P^F\left(\varepsilon_1 > \varepsilon_1^*\right)}Z$$

A6.5.2 Bank's optimisation problem

Optimisation in period zero is based on results obtained in period one:

$$\max_{\left\{L_0^B\right\}} \left\langle D_0^B + (1+\rho)^{-1} E_0^B \left[V_1^B \right] \right\rangle$$

s.t.

$$D_0^B \geq 0$$

$$L_0^B \geq 0$$

$$D_0^B = X_0^B - L_0^B$$

$$V_1^B = \max_{\left\{B_1, L_1^B\right\}} \left\langle D_1^B + (1+\rho)^{-1} E_1^B \left[D_2^B \right] \right\rangle$$

To solve the optimisation problem, we form the Lagrangian:

$$\begin{aligned} Q\left(L_0^B, \mu_0\right) = & \left[X_0^B - L_0^B \right] + \\ & + \frac{1}{1+\rho} \int_{\hat{\varepsilon}_1}^{\bar{\varepsilon}_1} \left[L_0^B \left(1+r_B\right) - L_1^B - B_1 \right] g\left(\varepsilon_1\right) d\varepsilon_1 + \\ & + \frac{1}{(1+\rho)^2} \int_{\hat{\varepsilon}_1}^{\bar{\varepsilon}_1} \int_{\underline{\varepsilon}_2^B}^{\bar{\varepsilon}_2} \left[L_1^B \left(1+r_B\right) \right] g\left(\varepsilon_2\right) g\left(\varepsilon_1\right) d\varepsilon_2 d\varepsilon_1 + \\ & + \frac{1}{(1+\rho)^2} \int_{\underline{\varepsilon}_1^B}^{\hat{\varepsilon}_1} \int_{\underline{\varepsilon}_2^B}^{\varepsilon_2^*} \left[F\left(I_1\right) + \varepsilon_2 \right] g\left(\varepsilon_2\right) g\left(\varepsilon_1\right) d\varepsilon_2 d\varepsilon_1 + \\ & + \frac{1}{(1+\rho)^2} \int_{\underline{\varepsilon}_1^B}^{\hat{\varepsilon}_1} \int_{\varepsilon_2^*}^{\bar{\varepsilon}_2} G\left(B_1\right) g\left(\varepsilon_2\right) g\left(\varepsilon_1\right) d\varepsilon_2 d\varepsilon_1 + \mu_0 \left[X_0^B - L_0^B \right] \end{aligned}$$

Based on the Lagrangian, we obtain the following first-order conditions:

$$\begin{aligned} \frac{\partial Q}{\partial L_0^B} = & -\left(1+\mu_0\right) + \frac{1}{1+\rho} \frac{\partial}{\partial L_0^B} \left[\left[L_0^B \left(1+r_B\right) - L_1^B \right] \frac{\bar{\varepsilon}_1 - \hat{\varepsilon}_1}{\bar{\varepsilon}_1 - \varepsilon_1^B} \right] + \\ & + \frac{1}{(1+\rho)^2} \frac{\partial}{\partial L_0^B} \left[L_1^B \left(1+r_B\right) \frac{\bar{\varepsilon}_1 - \hat{\varepsilon}_1}{\bar{\varepsilon}_1 - \varepsilon_1^B} \right] + \\ & + \frac{1}{(1+\rho)^2} \frac{\partial}{\partial L_0^B} \left[F\left(\hat{I}_1\right) P^B\left(\varepsilon_2 < \varepsilon_2^*\right) P^B\left(\varepsilon_1 < \hat{\varepsilon}_1\right) + \frac{\varepsilon_2^{*2} - \underline{\varepsilon}_2^{B2}}{2\left(\bar{\varepsilon}_2 - \varepsilon_2^B\right)} P^B\left(\varepsilon_1 < \hat{\varepsilon}_1\right) \right] + \\ & + \frac{1}{(1+\rho)^2} \frac{\partial}{\partial L_0^B} \left[G\left(B_1\right) P^B\left(\varepsilon_2 > \varepsilon_2^*\right) P^B\left(\varepsilon_1 < \hat{\varepsilon}_1\right) \right] \end{aligned}$$

$$\begin{aligned} \frac{\partial Q}{\partial L_0^B} = & -\left(1+\mu_0\right) + \frac{\left(1+r_B\right)^2}{(1+\rho)^2} P^B\left(\varepsilon_1 > \hat{\varepsilon}_1\right) + \frac{1}{1+\rho} \frac{\partial G\left(B_1\right)}{\partial B_1} \frac{\partial B_1}{\partial L_0^B} P^B\left(\varepsilon_2 > \varepsilon_2^*\right) P^B\left(\varepsilon_1 < \hat{\varepsilon}_1\right) + \\ & + \frac{1}{(1+\rho)^2} F\left(\hat{I}_1\right) P^B\left(\varepsilon_2 < \varepsilon_2^*\right) P^B\left(\varepsilon_1 < \hat{\varepsilon}_1\right) \end{aligned}$$

$$\frac{\partial Q}{\partial \mu_0} = \left[X_0^B - L_0^B \right] \geq 0; \quad \mu_0 \geq 0$$

If $L_0^B \geq 0$ and $\mu_0 \geq 0$ (endowment is high enough, therefore banks are not financially constrained):

$$\frac{\partial Q}{\partial L_0^B} = 0$$

$$1+\mu_0 = \frac{(1+r_B)^2}{(1+\rho)^2} P^B(\varepsilon_1 > \hat{\varepsilon}_1) + \frac{1}{1+\rho} \frac{\partial G(B_1)}{\partial B_1} \frac{\partial B_1}{\partial L_0^B} P^B(\varepsilon_2 > \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1) +$$
$$+ \frac{1}{(1+\rho)^2} F(\hat{I}_1) P^B(\varepsilon_2 < \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1)$$

$$1+\mu_0 = \frac{1}{(1+\rho)^2} \left[(1+r_B)^2 P^B(\varepsilon_1 > \hat{\varepsilon}_1) + G'(B_1)(1+r_B) P^B(\varepsilon_2 > \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1) \right] +$$
$$+ \frac{1}{(1+\rho)^2} F(\hat{I}_1) P^B(\varepsilon_2 < \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1)$$

$$G'(B_1)(1+r_B) P^B(\varepsilon_2 > \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1) =$$
$$= (1+\rho)^2 - (1+r_B)^2 P^B(\varepsilon_1 > \hat{\varepsilon}_1) - F(\hat{I}_1) P^B(\varepsilon_2 < \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1)$$

$$G'(B) = \frac{(1+\rho)^2}{(1+r_B) P^B(\varepsilon_2 > \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1)} - \frac{(1+r_B)^2 P^B(\varepsilon_1 > \hat{\varepsilon}_1)}{(1+r_B) P^B(\varepsilon_2 > \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1)} -$$
$$- \frac{P^B(\varepsilon_2 < \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1) F(\hat{I}_1)}{(1+r_B) P^B(\varepsilon_2 > \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1)}$$

$$G'(B) = \frac{(1+\rho)^2}{(1+r_B) P^B(\varepsilon_2 > \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1)} - \frac{(1+r_B) P^B(\varepsilon_1 > \hat{\varepsilon}_1)}{P^B(\varepsilon_2 > \varepsilon_2^*) P^B(\varepsilon_1 < \hat{\varepsilon}_1)} -$$
$$- F(\hat{I}_1) \frac{P^B(\varepsilon_2 < \varepsilon_2^*)}{(1+r_B) P^B(\varepsilon_2 > \varepsilon_2^*)}$$

If $P^B(\varepsilon_1 > \hat{\varepsilon}_1) = a$ and $P^B(\varepsilon_2 > \varepsilon_2^*) = b$, we can write:

$$G'(B) = \frac{(1+\rho)^2}{(1+r_B) b (1-a)} - \frac{(1+r_B) a}{b(1-a)} - F(\hat{I}_1) \frac{(1-b)}{(1+r_B) b}$$

Appendix 7: Chapter 4 – Summary statistics and tests for time series stationarity

Table A55: Description of the dataset

Variable	Transformation	Mean	Std. deviation	Percentiles			Source
				25th	Median	75th	
Lending rate for NFC	level	3.90	1.46	2.39	4.06	5.08	ECB Statistical Data Warehouse
Loans to NFC	y-o-y growth rate	0.21	8.57	-6.05	-2.23	7.06	ECB Statistical Data Warehouse
Business investment	y-o-y growth rate	1.69	11.05	-2.97	4.52	9.69	SORS
Country-level index of financial stress	y-o-y growth rate	27.24	98.23	-40.39	-4.95	66.33	ECB Statistical Data Warehouse
Euro area GDP	y-o-y growth rate	1.33	3.00	0.80	1.76	2.39	Eurostat
Shadow monetary policy rate	level	-0.54	3.83	-4.02	0.07	2.64	Wu and Xia (2017, 2020) and ECB Statistical Data Warehouse

Note: NFC refers to non-financial firms, and y-o-y refers to year-on-year.

Source: Own work.

Table A56: Test for the time series stationarity of NFC lending rate

	Estimate	Std. error	t value	Pr(>|t|)
z.lag.1	-0.014.	0.007	-1.823	0.072
exoMM	0.014.	0.008	1.888	0.062
exodGDP_EA	0.016	0.010	1.645	0.104
*** p < 0.001; ** p < 0.01; * p < 0.05: . < 0.1				
Value of the test statistic is: -1.823				
Critical values for test statistics:				
	1pct	5pct	10pct	
tau1	-2.6	-1.95	-1.61	

Note: In addition to the drift, we controlled for the correlation with shadow monetary policy rate (MM) and euro area GDP growth (GDP_EA). NFC stands for non-financial firms.

Source: Own work.

Table A57: Test for the time series stationarity of loans to NFC

	Estimate	Std. error	t value	Pr(>|t|)
z.lag.1	-0.120*	0.054	-2.236	0.028
exoMM	0.138	0.119	1.161	0.249
exodGDP_EA	0.087	0.103	0.843	0.401
*** p < 0.001; ** p < 0.01; * p < 0.05: . < 0.1				
Value of the test statistic is: -2.236				
Critical values for test statistics:				
	1pct	5pct	10pct	
tau1	-2.6	-1.95	-1.61	

Note: In addition to the drift, we controlled for the correlation with shadow monetary policy rate (MM) and euro area GDP growth (GDP_EA). NFC stands for non-financial firms.

Source: Own work.

Table A58: Test for the time series stationarity of business investment

	Estimate	Std. error	t value	Pr(>|t|)
z.lag.1	-0.470***	0.078	-6.037	0.000
exoMM	-0.129	0.193	-0.670	0.504
exodGDP_EA	1.220***	0.268	4.556	0.000
*** p < 0.001; ** p < 0.01; * p < 0.05: . < 0.1				
Value of the test statistic is: -6.037				
Critical values for test statistics:				
	1pct	5pct	10pct	
tau1	-2.6	-1.95	-1.61	

Note: In addition to the drift, we controlled for the correlation with shadow monetary policy rate (MM) and euro area GDP growth (GDP_EA). NFC stands for non-financial firms.

Source: Own work.

Table A59: Test for the time series stationarity of the country-level index of financial stress

	Estimate	Std. error	t value	Pr(>|t|)
z.lag.1	-0.474***	0.092	-5.144	0.000
exoMM	-2.731	2.362	-1.156	0.251
exodGDP_EA	-3.428	2.793	-1.227	0.223
*** p < 0.001; ** p < 0.01; * p < 0.05: . < 0.1				
Value of the test statistic is: -5.144				
Critical values for test statistics:				
	1pct	5pct	10pct	
tau1	-2.6	-1.95	-1.61	

Note: In addition to the drift, we controlled for the correlation with shadow monetary policy rate (MM) and euro area GDP growth (GDP_EA). NFC stands for non-financial firms.

Source: Own work.

Appendix 8: Chapter 4 – Estimation results

Table A60: Lag selection criteria

N. of lags / Criterion	1	2	3	4	5
AIC(n)	12.14	12.21	12.36	12.47	12.17
HQ(n)	12.47	12.73	13.07	13.37	13.27
SC(n)	12.96	13.51	14.13	14.72	14.89
FPE(n)	186,823.91	201,515.26	236,436.73	270,033.03	206,547.66
N. of lags / Criterion	6	7	8	9	10
AIC(n)	12.02	12.18	12.24	12.17	11.99
HQ(n)	13.30	13.65	13.90	14.02	14.03
SC(n)	15.21	15.85	16.38	16.79	17.07
FPE(n)	183,819.78	229,963.62	264,401.99	274,289.93	260,173.34

Source: Own work.

Table A61: Estimated coefficients of reduced form VAR model for the NFC lending rate equation

	Estimate	Std. error	t value	Pr(>|t|)
CL_NFC.l1	0.9205***	0.0362	25.449	0.000
dLOANR.l1	0.0120*	0.0048	2.502	0.014
dBI.l1	-0.0002	0.0032	-0.056	0.955
CLIFS.l1	0.0002	0.0003	0.512	0.610
constant	0.2759.	0.1593	1.732	0.087
MM	0.0171	0.0149	1.148	0.254
dGDP_EA	0.0078	0.0116	0.670	0.505
*** p < 0.001; ** p < 0.01; * p < 0.05: . < 0.1				

Note: CL_NFC represents the lending rate to non-financial firms, LOANR represents loans to non-financial firms, BI represents a business investment, CLIFS represents the country-level index of financial stress, MM represents shadow monetary policy rate, and GDP_EA represents the euro area GDP growth rate.

Source: Own work.

Table A62: Estimated coefficients of reduced form VAR model for the loans to NFC equation

	Estimate	Std. error	t value	Pr(>|t|)
CL_NFC.l1	-0.9897*	0.4317	-2.292	0.024
dLOANR.l1	0.8788***	0.0574	15.308	0.000
dBI.l1	-0.0234	0.0383	-0.613	0.542
CLIFS.l1	0.0005	0.0039	0.118	0.906
constant	3.9653*	1.9014	2.085	0.040
MM	0.4321*	0.1782	2.424	0.018
dGDP_EA	0.0453	0.1385	0.327	0.744

*** p < 0.001; ** p < 0.01; * p < 0.05: . < 0.1

Note: CL_NFC represents the lending rate to non-financial firms, LOANR represents loans to non-financial firms, BI represents a business investment, CLIFS represents the country-level index of financial stress, MM represents shadow monetary policy rate, and GDP_EA represents the euro area GDP growth rate.

Source: Own work.

Table A63: Estimated coefficients of reduced form VAR model for the business investment equation

	Estimate	Std. error	t value	Pr(>|t|)
CL_NFC.l1	-2.0576*	0.9483	-2.170	0.033
dLOANR.l1	-0.0967	0.1261	-0.767	0.445
dBI.l1	0.4739***	0.0841	5.637	0.000
CLIFS.l1	-0.0005	0.0086	-0.058	0.953
constant	7.6472.	4.1764	1.831	0.071
MM	0.5893	0.3915	1.505	0.136
dGDP_EA	1.2278***	0.3043	4.035	0.000

*** p < 0.001; ** p < 0.01; * p < 0.05: . < 0.1

Note: CL_NFC represents the lending rate to non-financial firms, LOANR represents loans to non-financial firms, BI represents a business investment, CLIFS represents the country-level index of financial stress, MM represents shadow monetary policy rate, and GDP_EA represents the euro area GDP growth rate.

Source: Own work.

Table A64: Estimated coefficients of reduced form VAR model for the CLIFS equation

	Estimate	Std. error	t value	Pr(>|t|)
CL_NFC.l1	-12.8931	11.0477	-1.167	0.247
dLOANR.l1	1.8701	1.4691	1.273	0.207
dBI.l1	1.4560	0.9794	1.487	0.141
CLIFS.l1	0.4024***	0.1004	4.008	0.000
constant	79.3685	48.6549	1.631	0.107
MM	-0.9093	4.5608	-0.199	0.842
dGDP_EA	-11.5819**	3.5451	-3.267	0.002
*** p < 0.001; ** p < 0.01; * p < 0.05: . < 0.1				

Note: CL_NFC represents the lending rate to non-financial firms, LOANR represents loans to non-financial firms, BI represents a business investment, CLIFS represents the country-level index of financial stress, MM represents shadow monetary policy rate, and GDP_EA represents the euro area GDP growth rate.

Source: Own work.

Table A65: Test for the residual autocorrelation

Portmanteau Test (asymptotic)	
Chi-squared	165.84
df	176
p-value	0.70

Source: Own work.

Table A66: Roots of the characteristic polynomial

	Roots
1	0.906
2	0.906
3	0.478
4	0.398

Source: Own work.

Appendix 9: Chapter 5 – Summary statistics and tests for time series stationarity

Table A67: Description of the additional data in the dataset of the macroeconometric model of the Slovenian economy

Variable	Transformation	Mean	Std. deviation	Percentiles			Source
				25th	Median	75th	
Lending rate for NFC	annual difference	-0.11	0.79	-0.57	-0.21	0.27	ECB Statistical Data Warehouse
Lending rate for HH	annual difference	-0.19	0.89	-0.67	-0.10	0.35	ECB Statistical Data Warehouse
Business investment	y-o-y growth rate	3.05	10.73	-1.94	4.94	10.91	SORS
Residential investment	y-o-y growth rate	0.52	11.12	-7.03	0.90	8.17	SORS
Gross operating surplus	y-o-y growth rate	5.34	6.63	1.52	5.08	8.99	SORS

Note: NFC and HH represent non-financial companies and households, respectively.

Source: Own work.

Table A68: Tests for the time series stationarity

Variable	Bandwidth	Phillips-Perron test statistic	Pr(>|t|)
Lending rate for NFC	3	-2.825	0.059
Lending rate for HH	3	-3.179	0.025
Business investment	6	-3.818	0.004
Residential investment	2	-2.699	0.078
Gross operating surplus	4	-3.622	0.007

Note: NFC and HH represent non-financial companies and households, respectively.

Source: Own work.

Appendix 10: Chapter 5 – Estimation results

Table A69: Estimated coefficients for the lending rate for households equation

	Estimate	Std. error	t value	Pr(>|t|)
C	0.010	0.044	0.221	0.825
CL_HH(-1)-CL_HH(-5)	0.686	0.061	11.235	0.000
GOV10Y-GOV10Y(-4)	0.122	0.034	3.630	0.001
SITBOR3M-SITBOR3M(-4)	0.137	0.037	3.732	0.000
Sample (adjusted): 2000Q2-2019Q4				
Included observations: 79 after adjustments				

Note: C – constant, CL_HH – lending rate for households, GOV10Y – 10-year government bond yield, SITBOR3M – 3-month interest rate before euro area access, and EURIBOR from 2007 onwards.

Source: Own work.

Table A70: Estimated coefficients for the lending rate for non-financial companies equation

	Estimate	Std. error	t value	Pr(>|t|)
C	0.025	0.039	0.658	0.513
CL_NFC(-1)-CL_NFC(-5)	0.711	0.060	11.925	0.000
GOV10Y-GOV10Y(-4)	0.135	0.031	4.369	0.000
SITBOR3M-SITBOR3M(-4)	0.068	0.030	2.264	0.027
Sample (adjusted): 2000Q2-2019Q4				
Included observations: 79 after adjustments				

Note: C – constant, CL_NFC – lending rate for non-financial companies, GOV10Y – 10-year government bond yield, SITBOR3M – 3-month interest rate before euro area access, and EURIBOR from 2007 onwards.

Source: Own work.

Table A71: Estimated coefficients for the gross operating surplus equation

	Estimate	Std. error	t value	Pr(>|t|)
C	0.007	0.006	1.177	0.243
LOG(DEMAND(-1)/DEMAND(-5))	0.879	0.110	7.991	0.000
Sample: 1999Q1-2019Q4				
Included observations: 84				

Note: C – constant, DEMAND – represents domestic demand, defined as a sum of private consumption, gross fixed capital formation, government consumptions, and foreign demand, approximated by the export of goods and services.

Source: Own work.

Table A72: Estimated coefficients for the residential investment equation

	Estimate	Std. error	t value	Pr(>|t|)
C	0.052	0.030	1.705	0.093
LOG(INVHR(-1)/INVHR(-5))	0.858	0.050	17.331	0.000
UCC_HH(-6)	-0.008	0.004	-1.859	0.067
LOG(INCOMER/INCOMER(-4))	0.274	0.146	1.878	0.064
Sample (adjusted): 2000Q4-2019Q4				
Included observations: 77 after adjustments				

Note: C – constant, INVHR – residential investment, UCC_HH – user cost of capital for residential investment, INCOMER – households' income.

Source: Own work.

Table A73: Estimated coefficients for the business investment equation

	Estimate	Std. error	t value	Pr(>|t|)
C	0.061	0.031	1.962	0.053
LOG(INVPR(-1)/INVPR(-5))	0.513	0.123	4.182	0.000
UCC_NFC(-1)	-0.017	0.007	-2.334	0.022
LOG(GOSR(-1)/GOSR(-5))	0.360	0.241	1.491	0.140
Sample (adjusted): 1999Q3-2019Q4				
Included observations: 82 after adjustments				

Note: C – constant, INVPR – business investment, UCC_NFC – user cost of capital for business investment, GOSR – gross operating surplus.

Source: Own work.

Appendix 11: Chapter 6 – Summary statistics and tests for time series stationarity

Table A74: Description of the dataset

Variable	Transformation	Mean	Std. deviation	Percentiles			Source
				25th	Median	75th	
CLIFS	level	0.00	0.09	-0.06	-0.02	0.03	ECB Statistical Data Warehouse
General government debt	y-o-y growth rate	0.00	11.57	-5.49	-1.25	2.76	Eurostat
Interest rate spread	level	0.00	1.94	-0.98	-0.18	0.73	ECB Statistical Data Warehouse
Real GDP	y-o-y growth rate	0.00	3.59	-1.21	0.33	1.93	Eurostat
GDP deflator	y-o-y growth rate	0.00	2.69	-1.19	-0.13	0.94	Eurostat

Note: CLIFS refers to the country-level index of financial stress.

Source: Own work.

Table A75: Tests for the time series stationarity

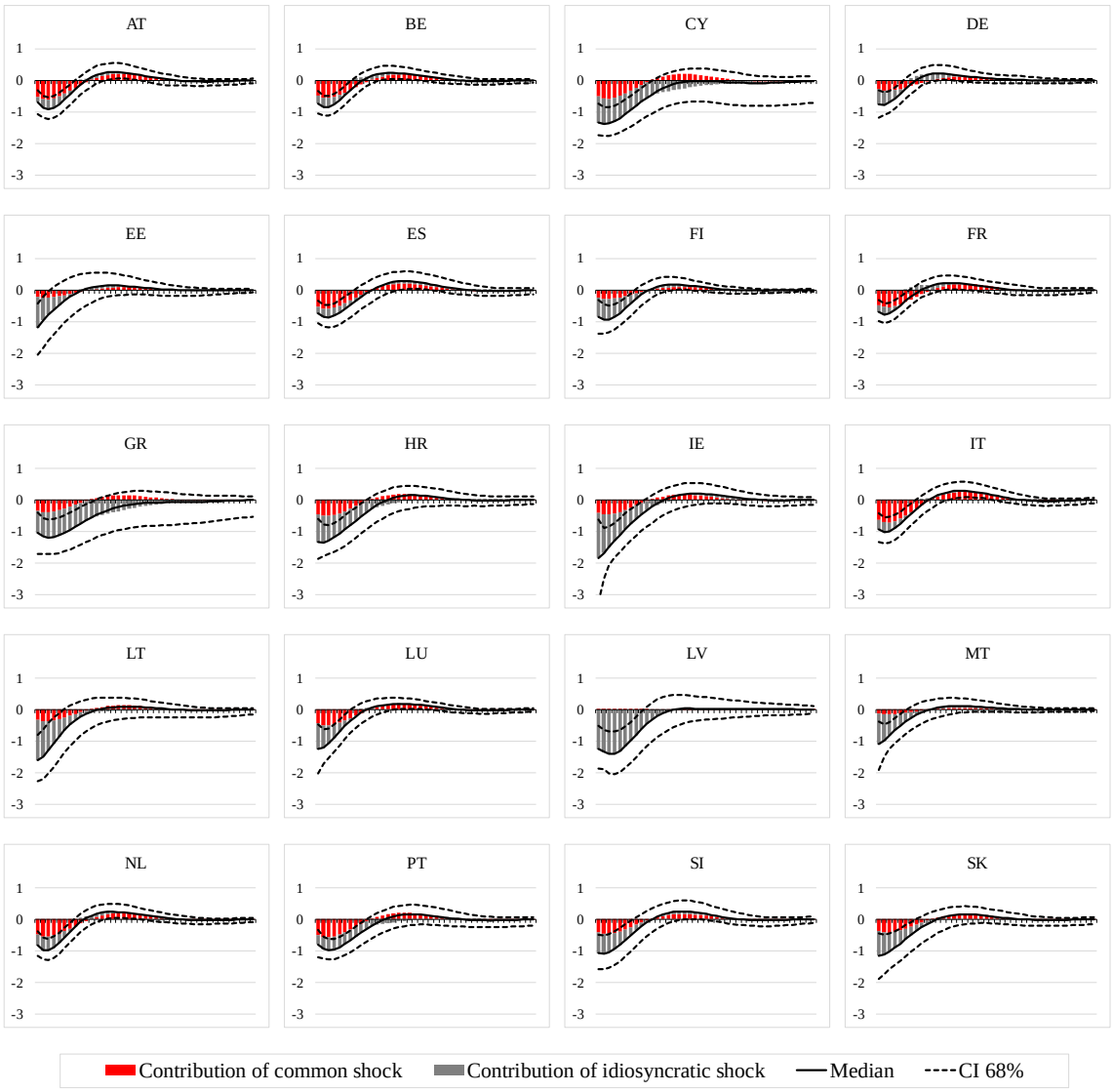
Variable	W-t-bar test statistics	p-value
CLIFS	-6.779	0.000
General government debt	-3.072	0.001
Interest rate spread	-6.033	0.000
Real GDP	-5.380	0.000
GDP deflator	-5.251	0.000
Ho: All panels contain unit roots Ha: Some panels are stationary		

Note: CLIFS refers to the country-level index of financial stress.

Source: Own work.

Appendix 12: Chapter 6 – Impulse responses of real GDP, GDP deflator and CLIFS to a financial shock

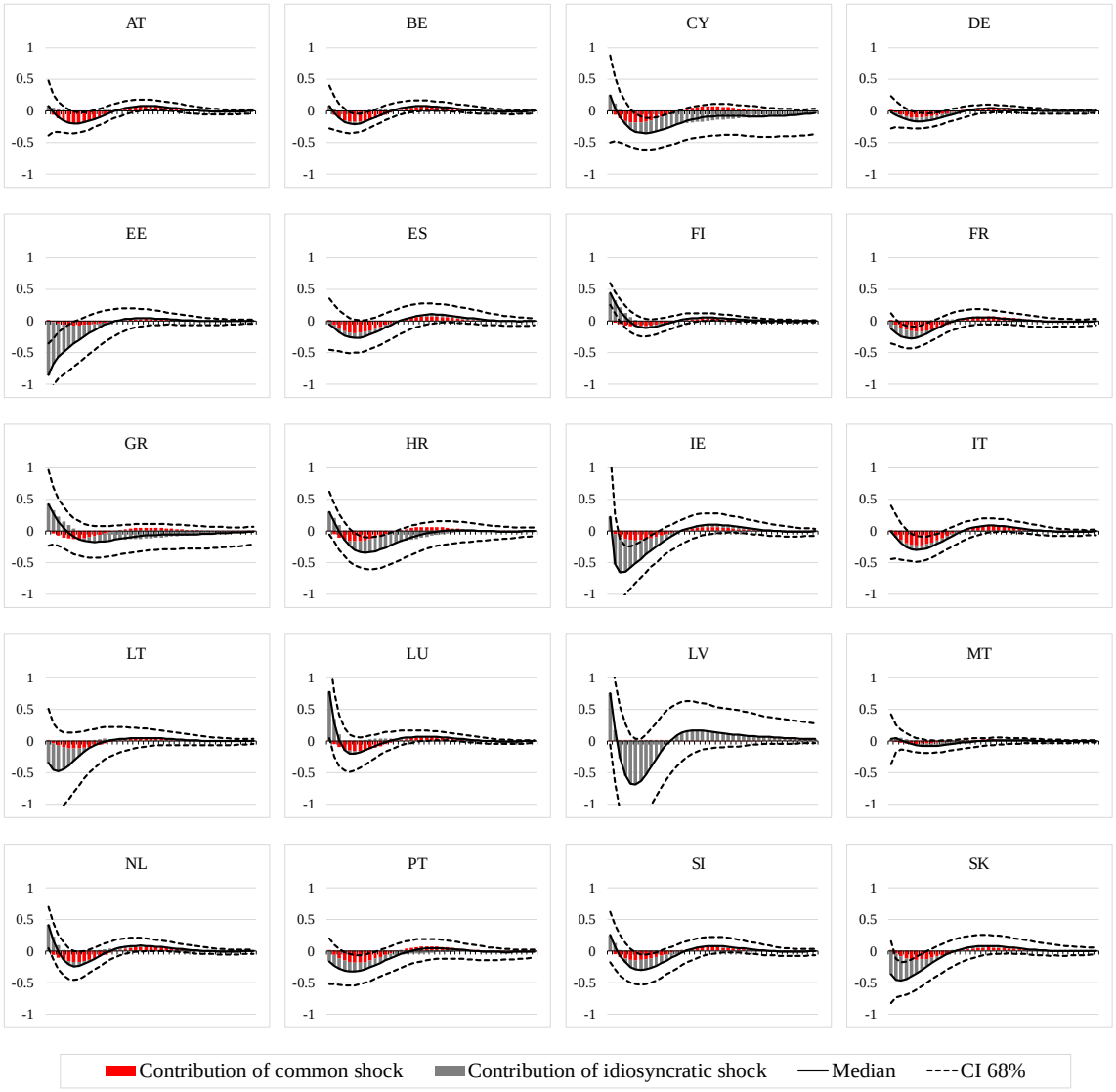
Figure A5: Responses of real GDP to a financial shock (in p.p.)



Note: AT – Austria, BE – Belgium, CY – Cyprus, DE – Germany, EE – Estonia, ES – Spain, FI – Finland, FR – France, GR – Greece, HR – Croatia, IE – Ireland, IT – Italy, LT – Lithuania, LU – Luxembourg, LV – Latvia, MT – Malta, NL – the Netherlands, PT – Portugal, SI – Slovenia, SK – Slovakia. Horizontal axes represent quarters after the initial shock.

Source: Own work.

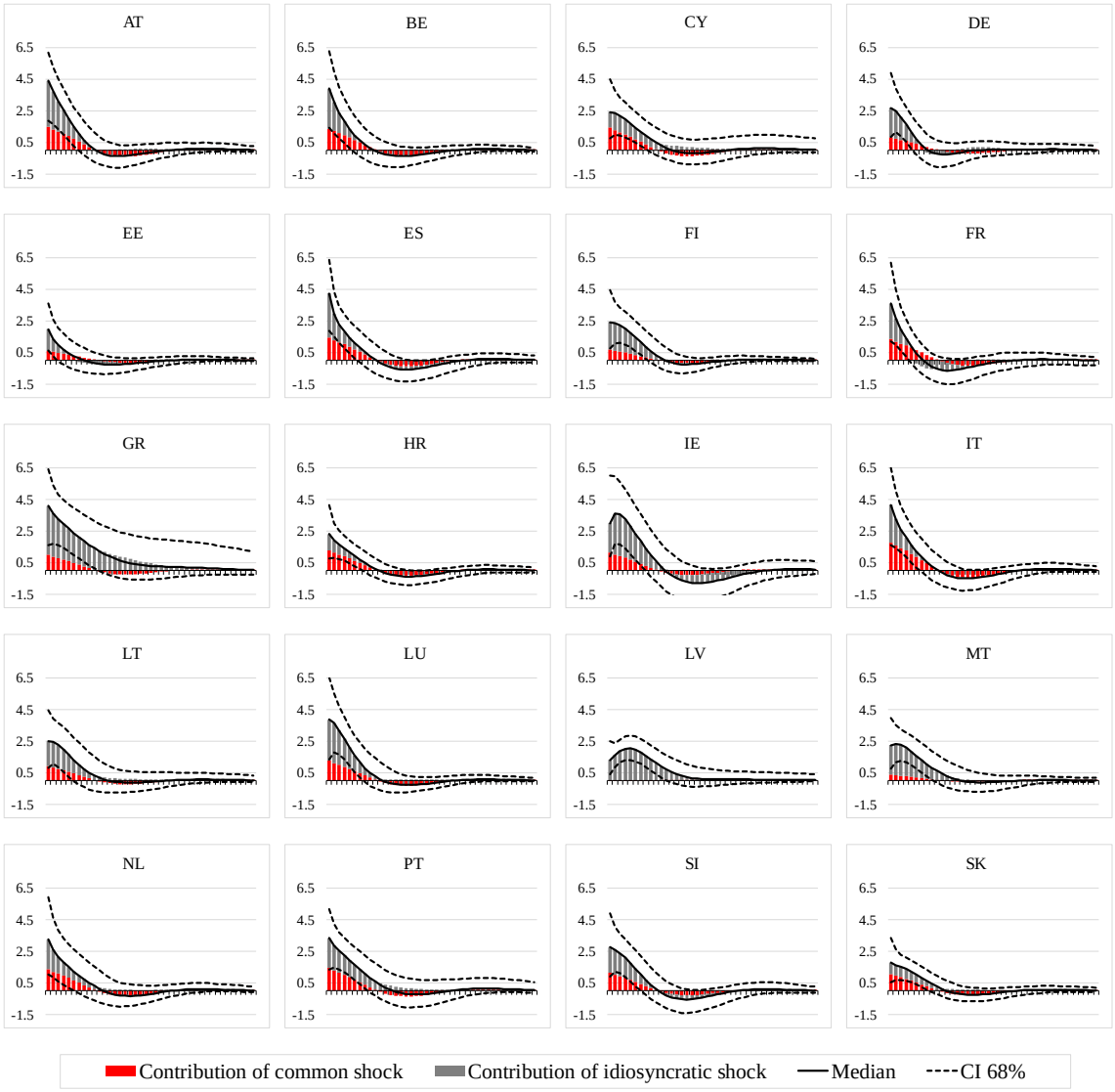
Figure A6: Responses of GDP deflator to a financial shock (in p.p.)



Note: AT – Austria, BE – Belgium, CY – Cyprus, DE – Germany, EE – Estonia, ES – Spain, FI – Finland, FR – France, GR – Greece, HR – Croatia, IE – Ireland, IT – Italy, LT – Lithuania, LU – Luxembourg, LV – Latvia, MT – Malta, NL – the Netherlands, PT – Portugal, SI – Slovenia, SK – Slovakia. Horizontal axes represent quarters after the initial shock.

Source: Own work.

Figure A7: Responses of CLIFS to a financial shock (in index points)



Note: AT – Austria, BE – Belgium, CY – Cyprus, DE – Germany, EE – Estonia, ES – Spain, FI – Finland, FR – France, GR – Greece, HR – Croatia, IE – Ireland, IT – Italy, LT – Lithuania, LU – Luxembourg, LV – Latvia, MT – Malta, NL – the Netherlands, PT – Portugal, SI – Slovenia, SK – Slovakia. Horizontal axes represent quarters after the initial shock.

Source: Own work.

Appendix 13: Chapter 6 – Estimation results

Table A76: Estimated coefficients in the SPVAR model

Country	Variable	CLIFS.l1	D.l1	Spread.l1	GDPR.l1	GDPD.l1	constant
BE	CLIFS	0.806	-0.001	-0.005	0.001	-0.007	0.007
		(0.073)	(0.003)	(0.008)	(0.005)	(0.009)	(0.012)
	D	5.036	0.723	-0.169	-0.262	0.417	0.233
		(1.815)	(0.079)	(0.196)	(0.123)	(0.235)	(0.308)
	Spread	1.284	-0.009	0.856	-0.120	-0.010	0.193
		(0.413)	(0.018)	(0.045)	(0.028)	(0.053)	(0.070)
	GDPR	-2.824	-0.005	0.313	0.883	-0.494	-0.424
		(0.808)	(0.035)	(0.087)	(0.055)	(0.105)	(0.137)
	GDPD	0.202	0.011	0.007	0.112	0.645	-0.001
		(0.607)	(0.026)	(0.065)	(0.041)	(0.079)	(0.103)
DE	CLIFS	0.638	0.005	-0.034	-0.007	-0.003	0.030
		(0.104)	(0.002)	(0.01)	(0.004)	(0.013)	(0.011)
	D	6.35	0.709	0.703	0.097	-0.862	-0.405
		(4.112)	(0.081)	(0.398)	(0.167)	(0.526)	(0.442)
	Spread	2.331	-0.009	0.844	-0.024	-0.062	0.167
		(0.532)	(0.010)	(0.052)	(0.022)	(0.068)	(0.057)
	GDPR	-7.451	-0.031	0.828	0.700	-0.173	-0.823
		(2.042)	(0.040)	(0.198)	(0.083)	(0.261)	(0.220)
	GDPD	0.747	-0.006	-0.091	0.018	0.770	0.160
		(0.697)	(0.014)	(0.068)	(0.028)	(0.089)	(0.075)
IE	CLIFS	0.806	0.002	-0.014	-0.002	0.004	0.034
		(0.087)	(0.001)	(0.005)	(0.002)	(0.003)	(0.015)
	D	21.622	0.743	-0.501	-0.095	0.093	0.817
		(8.172)	(0.099)	(0.466)	(0.192)	(0.311)	(1.384)
	Spread	1.013	0.015	0.891	0.005	0.029	0.248
		(0.616)	(0.007)	(0.035)	(0.014)	(0.023)	(0.104)
	GDPR	-3.005	-0.079	0.147	0.552	-0.068	-0.725
		(4.956)	(0.060)	(0.283)	(0.116)	(0.189)	(0.839)
	GDPD	3.914	-0.060	0.248	0.208	0.446	-0.896
		(2.275)	(0.028)	(0.130)	(0.053)	(0.087)	(0.385)
GR	CLIFS	0.776	0.000	-0.001	-0.004	0.002	0.003
		(0.093)	(0.002)	(0.003)	(0.003)	(0.005)	(0.014)
	D	1.835	0.811	0.019	0.018	0.258	-0.036
		(3.52)	(0.075)	(0.098)	(0.103)	(0.174)	(0.537)
	Spread	0.203	-0.071	0.829	-0.222	0.104	0.889
		(2.169)	(0.046)	(0.060)	(0.063)	(0.107)	(0.331)
	GDPR	-6.708	-0.039	0.111	0.865	0.122	-0.690
		(2.752)	(0.059)	(0.077)	(0.080)	(0.136)	(0.420)
	GDPD	2.617	0.024	-0.077	0.069	0.730	0.267
		(1.717)	(0.037)	(0.048)	(0.050)	(0.085)	(0.262)

To be continued

Table A76: Estimated coefficients in the SPVAR model (cont.)

Country	Variable	CLIFS.l1	D.l1	Spread.l1	GDPR.l1	GDPD.l1	constant
ES	CLIFS	0.560	0.000	-0.015	-0.013	-0.003	0.029
		(0.099)	(0.001)	(0.006)	(0.005)	(0.005)	(0.013)
	D	17.668	0.690	-0.382	-0.677	0.030	0.601
		(4.890)	(0.063)	(0.291)	(0.257)	(0.224)	(0.643)
	Spread	1.571	0.001	0.827	-0.064	0.009	0.312
		(0.711)	(0.009)	(0.042)	(0.037)	(0.032)	(0.094)
	GDPR	-3.737	0.037	0.146	1.033	-0.010	-0.305
		(0.991)	(0.013)	(0.059)	(0.052)	(0.045)	(0.130)
	GDPD	0.653	0.006	0.041	0.136	0.863	-0.103
		(0.984)	(0.013)	(0.059)	(0.052)	(0.045)	(0.129)
FR	CLIFS	0.659	0.001	-0.022	-0.006	0.002	0.025
		(0.112)	(0.003)	(0.012)	(0.008)	(0.011)	(0.017)
	D	4.878	0.763	-0.290	-0.597	0.352	0.135
		(2.366)	(0.062)	(0.248)	(0.172)	(0.244)	(0.370)
	Spread	2.594	0.002	0.819	-0.018	-0.062	0.221
		(0.536)	(0.014)	(0.056)	(0.039)	(0.055)	(0.084)
	GDPR	-4.847	0.034	0.361	0.755	0.051	-0.554
		(1.016)	(0.027)	(0.106)	(0.074)	(0.105)	(0.159)
	GDPD	-0.405	0.033	-0.008	0.136	0.859	0.058
		(0.508)	(0.013)	(0.053)	(0.037)	(0.052)	(0.080)
HR	CLIFS	0.342	-0.001	0.012	0.002	0.013	-0.032
		(0.125)	(0.001)	(0.008)	(0.003)	(0.005)	(0.021)
	D	0.184	0.796	0.125	-0.193	0.583	-0.547
		(10.339)	(0.072)	(0.622)	(0.244)	(0.398)	(1.723)
	Spread	1.877	-0.003	0.857	-0.077	0.067	0.458
		(2.004)	(0.014)	(0.121)	(0.047)	(0.077)	(0.334)
	GDPR	-12.264	0.010	-0.260	0.714	-0.133	0.513
		(5.809)	(0.041)	(0.350)	(0.137)	(0.223)	(0.968)
	GDPD	8.182	0.025	-0.331	0.042	0.591	0.813
		(2.519)	(0.018)	(0.152)	(0.059)	(0.097)	(0.42)
IT	CLIFS	0.763	-0.009	-0.006	-0.007	-0.004	0.008
		(0.09)	(0.005)	(0.006)	(0.004)	(0.008)	(0.015)
	D	2.626	0.465	0.123	-0.153	0.291	-0.285
		(1.594)	(0.096)	(0.112)	(0.078)	(0.138)	(0.259)
	Spread	2.346	-0.062	0.900	-0.025	0.044	0.250
		(0.654)	(0.039)	(0.046)	(0.032)	(0.057)	(0.106)
	GDPR	-5.071	0.298	0.072	0.860	-0.198	-0.329
		(1.336)	(0.080)	(0.094)	(0.065)	(0.116)	(0.217)
	GDPD	0.740	-0.007	-0.099	0.062	0.745	0.197
		(0.982)	(0.059)	(0.069)	(0.048)	(0.085)	(0.160)

To be continued

Table A76: Estimated coefficients in the SPVAR model (cont.)

Country	Variable	CLIFS.l1	D.l1	Spread.l1	GDPR.l1	GDPD.l1	constant
CY	CLIFS	0.602	0.000	0.006	-0.001	0.007	-0.020
		(0.090)	(0.001)	(0.005)	(0.002)	(0.003)	(0.015)
	D	-1.401	0.635	0.251	-0.519	0.389	-1.081
		(15.029)	(0.098)	(0.757)	(0.322)	(0.550)	(2.500)
	Spread	-0.941	0.006	0.909	-0.053	0.033	0.260
		(1.135)	(0.007)	(0.057)	(0.024)	(0.042)	(0.189)
	GDPR	-3.395	-0.001	0.102	0.949	-0.014	-0.333
		(2.917)	(0.019)	(0.147)	(0.062)	(0.107)	(0.485)
	GDPD	0.248	0.009	-0.246	0.030	0.658	0.737
		(2.491)	(0.016)	(0.126)	(0.053)	(0.091)	(0.414)
LV	CLIFS	0.593	0.001	0.000	-0.001	-0.001	-0.004
		(0.087)	(0.000)	(0.003)	(0.001)	(0.001)	(0.011)
	D	-56.388	0.633	0.490	-2.436	1.693	-2.561
		(32.555)	(0.099)	(1.184)	(0.535)	(0.416)	(4.111)
	Spread	-4.200	0.033	0.794	-0.020	0.000	0.517
		(1.208)	(0.004)	(0.044)	(0.020)	(0.015)	(0.153)
	GDPR	0.725	-0.061	0.405	0.813	0.040	-1.264
		(5.155)	(0.016)	(0.188)	(0.085)	(0.066)	(0.651)
	GDPD	14.415	-0.039	0.288	0.312	0.779	-0.661
		(4.648)	(0.014)	(0.169)	(0.076)	(0.059)	(0.587)
LT	CLIFS	0.715	-0.001	0.005	-0.004	0.004	-0.016
		(0.116)	(0.001)	(0.005)	(0.002)	(0.002)	(0.014)
	D	34.579	0.453	0.976	-0.499	0.402	-1.951
		(14.245)	(0.082)	(0.570)	(0.223)	(0.239)	(1.715)
	Spread	6.241	-0.056	0.969	-0.035	0.131	0.220
		(2.794)	(0.016)	(0.112)	(0.044)	(0.047)	(0.336)
	GDPR	-14.117	0.102	0.001	0.908	-0.172	-0.369
		(5.473)	(0.032)	(0.219)	(0.086)	(0.092)	(0.659)
	GDPD	4.624	0.052	-0.435	0.126	0.705	1.079
		(3.878)	(0.022)	(0.155)	(0.061)	(0.065)	(0.467)
LU	CLIFS	0.769	0.000	-0.004	-0.004	0.005	-0.001
		(0.111)	(0.001)	(0.011)	(0.003)	(0.004)	(0.013)
	D	66.287	0.429	-4.088	-0.615	2.252	4.180
		(23.95)	(0.122)	(2.367)	(0.608)	(0.778)	(2.839)
	Spread	1.244	0.007	0.713	-0.026	0.000	0.268
		(0.501)	(0.003)	(0.049)	(0.013)	(0.016)	(0.059)
	GDPR	-4.703	-0.010	0.482	0.639	-0.095	-0.731
		(3.855)	(0.020)	(0.381)	(0.098)	(0.125)	(0.457)
	GDPD	-0.636	-0.006	0.150	0.111	0.644	-0.076
		(3.070)	(0.016)	(0.303)	(0.078)	(0.100)	(0.364)

To be continued

Table A76: Estimated coefficients in the SPVAR model (cont.)

Country	Variable	CLIFS.l1	D.l1	Spread.l1	GDPR.l1	GDPD.l1	constant
MT	CLIFS	0.724	0.000	0.001	-0.005	0.004	0.000
		(0.080)	(0.002)	(0.007)	(0.002)	(0.006)	(0.015)
	D	-1.718	0.669	0.390	-0.121	0.469	-0.889
		(4.921)	(0.105)	(0.408)	(0.114)	(0.364)	(0.903)
	Spread	-0.074	0.018	0.904	-0.024	0.104	0.194
		(0.615)	(0.013)	(0.051)	(0.014)	(0.045)	(0.113)
	GDPR	-1.543	-0.138	0.380	0.649	-0.249	-0.730
		(4.349)	(0.093)	(0.361)	(0.100)	(0.322)	(0.798)
	GDPD	1.484	0.051	-0.312	0.021	0.477	0.649
		(1.386)	(0.030)	(0.115)	(0.032)	(0.103)	(0.254)
NL	CLIFS	0.753	-0.002	-0.006	-0.008	0.000	0.003
		(0.090)	(0.001)	(0.012)	(0.007)	(0.006)	(0.014)
	D	11.186	0.800	-1.987	-0.047	0.280	2.324
		(6.829)	(0.100)	(0.922)	(0.501)	(0.464)	(1.054)
	Spread	0.897	0.021	0.757	-0.042	0.039	0.256
		(0.407)	(0.006)	(0.055)	(0.03)	(0.028)	(0.063)
	GDPR	-2.098	-0.069	0.389	0.739	-0.076	-0.608
		(1.037)	(0.015)	(0.140)	(0.076)	(0.070)	(0.160)
	GDPD	0.791	-0.029	-0.073	0.053	0.715	0.052
		(1.019)	(0.015)	(0.138)	(0.075)	(0.069)	(0.157)
AT	CLIFS	0.938	-0.002	-0.007	0.003	0.005	0.008
		(0.087)	(0.001)	(0.008)	(0.004)	(0.010)	(0.012)
	D	10.598	0.512	0.942	0.014	1.447	-1.419
		(6.355)	(0.102)	(0.623)	(0.311)	(0.737)	(0.900)
	Spread	1.044	0.010	0.712	-0.099	-0.171	0.371
		(0.572)	(0.009)	(0.056)	(0.028)	(0.066)	(0.081)
	GDPR	-6.676	0.067	0.337	0.786	-0.171	-0.531
		(1.346)	(0.022)	(0.132)	(0.066)	(0.156)	(0.191)
	GDPD	0.289	0.012	-0.076	0.027	0.556	0.198
		(0.890)	(0.014)	(0.087)	(0.044)	(0.103)	(0.126)
PT	CLIFS	0.754	0.001	-0.002	0.000	-0.011	0.006
		(0.103)	(0.001)	(0.003)	(0.003)	(0.006)	(0.008)
	D	8.898	0.856	-0.330	-0.146	0.074	0.847
		(6.988)	(0.067)	(0.190)	(0.231)	(0.407)	(0.549)
	Spread	2.959	0.067	0.892	0.064	-0.061	0.334
		(1.712)	(0.016)	(0.047)	(0.057)	(0.100)	(0.134)
	GDPR	-7.125	-0.053	0.004	0.683	-0.008	-0.167
		(2.459)	(0.024)	(0.067)	(0.081)	(0.143)	(0.193)
	GDPD	-1.155	-0.013	-0.028	-0.051	0.844	-0.015
		(1.459)	(0.014)	(0.040)	(0.048)	(0.085)	(0.115)

To be continued

Table A76: Estimated coefficients in the SPVAR model (cont.)

Country	Variable	CLIFS.l1	D.l1	Spread.l1	GDPR.l1	GDPD.l1	constant
SI	CLIFS	0.660	0.000	-0.013	-0.008	0.002	0.031
		(0.088)	(0.001)	(0.004)	(0.003)	(0.003)	(0.013)
	D	-16.148	0.665	-0.177	-1.621	0.472	0.156
		(11.635)	(0.077)	(0.525)	(0.333)	(0.377)	(1.697)
	Spread	2.238	-0.016	0.879	-0.066	0.005	0.184
		(0.913)	(0.006)	(0.041)	(0.026)	(0.030)	(0.133)
	GDPR	-6.948	0.046	0.053	0.904	-0.104	-0.269
		(2.652)	(0.018)	(0.120)	(0.076)	(0.086)	(0.387)
	GDPD	1.640	-0.020	0.050	0.096	0.815	-0.452
		(1.267)	(0.008)	(0.057)	(0.036)	(0.041)	(0.185)
SK	CLIFS	0.512	0.000	0.003	-0.001	-0.005	-0.020
		(0.101)	(0.001)	(0.005)	(0.001)	(0.002)	(0.012)
	D	4.697	0.862	-0.380	-0.191	0.359	1.093
		(13.443)	(0.081)	(0.614)	(0.197)	(0.325)	(1.603)
	Spread	0.776	0.015	0.781	-0.061	0.072	0.500
		(1.274)	(0.008)	(0.058)	(0.019)	(0.031)	(0.152)
	GDPR	1.749	-0.034	0.313	0.844	0.022	-0.592
		(5.806)	(0.035)	(0.265)	(0.085)	(0.14)	(0.692)
	GDPD	-2.044	-0.044	0.467	0.155	0.639	-1.404
		(2.925)	(0.018)	(0.134)	(0.043)	(0.071)	(0.349)
FI	CLIFS	0.704	0.000	-0.007	-0.005	0.005	0.001
		(0.098)	(0.001)	(0.010)	(0.002)	(0.006)	(0.013)
	D	17.772	0.457	0.552	-0.478	-0.684	-0.797
		(9.512)	(0.105)	(1.000)	(0.232)	(0.600)	(1.28)
	Spread	1.507	-0.007	0.797	-0.039	-0.024	0.220
		(0.632)	(0.007)	(0.066)	(0.015)	(0.04)	(0.085)
	GDPR	-2.927	0.029	0.453	0.842	-0.354	-0.701
		(2.976)	(0.033)	(0.313)	(0.073)	(0.188)	(0.400)
	GDPD	0.154	0.021	-0.169	0.080	0.808	0.220
		(1.097)	(0.012)	(0.115)	(0.027)	(0.069)	(0.148)
EE	CLIFS	0.635	0.000	0.000	-0.004	0.006	-0.002
		(0.090)	(0.000)	(0.003)	(0.001)	(0.002)	(0.014)
	D	-7.085	0.787	-0.424	-0.542	0.778	2.444
		(21.365)	(0.073)	(0.732)	(0.313)	(0.453)	(3.386)
	Spread	-1.446	0.019	0.739	-0.048	0.017	1.141
		(2.112)	(0.007)	(0.072)	(0.031)	(0.045)	(0.335)
	GDPR	2.170	-0.013	0.176	0.976	-0.220	-1.043
		(5.634)	(0.019)	(0.193)	(0.083)	(0.119)	(0.893)
	GDPD	9.614	0.001	-0.205	0.253	0.532	0.713
		(3.908)	(0.013)	(0.134)	(0.057)	(0.083)	(0.619)

To be continued

Table A76: Estimated coefficients in the SPVAR model (cont.)

Country	Variable	CLIFS.l1	D.l1	Spread.l1	GDPR.l1	GDPD.l1	constant
Euro area	CLIFS	0.777	0.001	-0.010	-0.003	0.001	-0.001
		(0.081)	(0.001)	(0.004)	(0.003)	(0.003)	(0.003)
	D	18.126	0.597	-0.297	-0.837	0.910	-0.032
		(5.811)	(0.074)	(0.272)	(0.192)	(0.244)	(0.234)
	Spread	2.963	-0.011	0.847	-0.088	0.070	-0.022
		(0.843)	(0.011)	(0.039)	(0.028)	(0.035)	(0.034)
	GDPR	-5.225	0.047	0.292	1.085	-0.218	-0.010
		(2.001)	(0.025)	(0.094)	(0.066)	(0.084)	(0.080)
	GDPD	1.202	0.012	0.027	0.174	0.750	-0.049
		(0.998)	(0.013)	(0.047)	(0.033)	(0.042)	(0.040)

Note: AT – Austria, BE – Belgium, CY – Cyprus, DE – Germany, EE – Estonia, ES – Spain, FI – Finland, FR – France, GR – Greece, HR – Croatia, IE – Ireland, IT – Italy, LT – Lithuania, LU – Luxembourg, LV – Latvia, MT – Malta, NL – the Netherlands, PT – Portugal, SI – Slovenia, SK – Slovakia.
CLIFS – country-level index of financial stress, D – general government debt, Spread – interest rate spread, GDPR – real GDP, GDPD – GDP deflator.
Standard errors are reported in the brackets.

Source: Own work.